Cost Accounting and Budgeting for Improved Wastewater Treatment

Prepared for:

Office of Policy, Planning and Evaluation
and Office of Water
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

Prepared by:

Industrial Economics, Incorporated
2067 Massachusetts Avenue
Cambridge, MA 02140

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INTRODUCTION

Publicly-owned treatment works (POTWs) face a challenging task. They must take polluted discharges from a variety of customers and treat it to a level that will not harm human health or the environment. They are regulated both at the state and federal level, and directly regulate discharging industries. POTW managers do not always have accurate or timely information on the economic performance of the treatment system. Pretreatment managers, often somewhat isolated in their own section of the POTW, may have even less information on which to base decisions.

This guidance manual aims to show POTW managers how effective budgeting and cost accounting systems can help them do a better job running their plants with limited resources. Although POTWs are commonly divided into different operating departments, activities of one group often have substantial impacts on others. For example, effective pretreatment plays a vital role in preventing plant upsets, thereby keeping plant operating costs low. Because decisions in one part of the POTW affect other departments, we have chosen to analyze budgeting and cost accounting systems holistically rather than within pretreatment alone.

The impetus for this project came out of the Common Sense Initiative for the Metal Finishing Sector. A number of industry participants in the initiative noted that POTW pretreatment programs had an extremely large impact on their business, but that the efficacy with which POTWs were operated varied considerably across geographic regions. During the first part of 1996, the Agency visited fourteen POTWs in three states to identify what factors made pretreatment programs successful, and what barriers prevented struggling programs from improving. Nearly every program, including those widely recognized as having top-tier pretreatment, had important weaknesses in their cost accounting and budgeting systems that impeded their ability to make optimal decisions. Our goal in preparing this report is to demonstrate how poor cost accounting and budgeting systems can lead to sub-optimal outcomes, to educate POTW staff about common problem areas to evaluate in their own programs, and to provide guidance on how to implement improved cost accounting and budgeting systems.

The report contains five chapters. Chapter one explains cost accounting and budgeting in more detail, including what it is, how it works, and why it is important. Chapter two provides background information on important tools that program managers can use in their utilities to help them prioritize their activities. Chapter three discusses common issues associated with POTW cost accounting and budgeting. Chapter four examines two plants in detail, illustrating the multiple issues that arise at real facilities. Chapter five contains the summary.

1. OVERVIEW OF BUDGETING AND COST ACCOUNTING FOR WASTEWATER TREATMENT

Much of the historic emphasis at Publicly-Owned Treatment Works (POTWs) has been on the engineering: building new capacity, preventing plant upsets, and ensuring that treated effluents and biosolids meet permit requirements. Less attention has been paid to budgeting and cost accounting, which involve the financial side of wastewater treatment: what are the utility's available resources (budgeting) and how do costs vary with different activities (cost accounting). The engineering and the financial aspects of the enterprise are, not surprisingly, closely linked. Different engineering approaches will have very different impacts on the cost of running the plant.

Budgeting and cost accounting themselves should also be closely linked. Budgets report the allocation of POTW resources to particular expenses. A budget document serves as a written expression of management's resource allocation decisions and as a benchmark against which on-going operations can be measured. Cost accounting is the process by which these expenses are allocated to particular activities. Whereas a budget line item might simply be "pretreatment inspector salaries," cost accounting defines *activities* of the POTW more broadly. Under the pretreatment activity, pretreatment salaries would be included along with a host of other costs that are sometimes overlooked, such as computer programming provided by the town's information systems department or laboratory tests required for particular industrial users. By reworking existing budget categories to better reflect the core activities the enterprise provides (even if they cut across existing budget accounts or departments), insights from cost accounting can be integrated into the budget planning process.

Neither budgeting nor cost accounting tend to rank among most people's favorite activities. Budget time in any organization can be hectic and stressful, with staff having to justify every dollar of their budget request before their managers, sometimes a year or more ahead of time. Cost accounting may be less visible within the utility. When it is encountered, it may be viewed somewhat perjoratively, using terms such as "bean counting." Stepping back from their implementation, both budgeting and cost accounting are critically important to the effective operation of the treatment plant. They are simply tools that help managers and their staff decide how to prioritize limited funds across the many competing options for those funds. When implemented creatively, these systems provide important and timely information to decision-makers. For example:

- *What are our short- and long-term financial constraints on activities?* These constraints need to be recognized not only at the utility-level, but at the program-level as well.

- *Including all inputs, what is the annualized cost of our services, and how do we expect this to change over time?* To remain a healthy enterprise, the POTW needs to understand its total cost of treating wastewater. Evaluating how the costs will change over time enables the staff to plan for required upgrades over a longer horizon, avoiding sudden spikes in the rates or large revenue shortfalls.

- *Are there differences in our cost of service across regions of the utility district, or across different customers?* Unless managers understand how their costs of service vary based on the location or characteristics of a discharger they will not be able to prioritize what areas deserve their focus first. It is important for managers to separate the economic from the political here. For example, the economic cost of handling the same type of discharge in different parts of a complex, multi-plant treatment system may vary widely. Nonetheless, managers may still decide, for political or equity reasons, to have uniform charges for customers in different parts of the system. However, they may focus inspection and outreach activities in the portion of their district where cost impacts are the highest.

- *How do current or proposed actions by dischargers affect our costs and performance?* Prioritizing management attention also requires understanding how certain types of discharges affect the treatment system, and estimating how particular changes in discharge levels or types will affect system operation and costs.

Our focus in this report is on powerful applications of cost accounting within the POTW, and on ways to change the structure of the budget and the budgeting rules to allow greater flexibility for program managers to run their programs.

<u>Budgeting Systems</u>

Budgets serve a variety of purposes within an organization.[1] They help the organization to plan for the future by estimating the resource requirements of different portions of the enterprise. They help managers communicate priorities and constraints to staff, as well as illustrate what items fall under the control/responsibility of which departments. Budgets can also be used to help evaluate performance, for example, by comparing budgeted and actual performance. Variances between budgeted and actual performance can also help the organization to identify areas where their market or

[1] Robert Anthony and James Reece, *Accounting Principles,* (Irwin: Homewood, IL, 1989), pp. 603, 604.

performance is changing. These purposes can sometimes work in conflict, so it is important to consider the most important goals for a particular POTW when designing a new budgeting system.

Our visits to POTW pretreatment programs found an extremely wide range of budgeting systems currently in use. Some pretreatment program managers never even saw their budget. Rather, operating as a small part of a larger utility district, pretreatment staff would simply put in budget requests until an “invisible line” of spending was passed and their requests were denied. This line varied year-by-year, and applied not only to aggregate spending but to individual purchases as well. The larger the individual purchase, the more likely it was to be denied. This type of budgeting approach meets none of the goals of effective budgeting. Department level managers were not educated by the information; nor could they be reasonably evaluated based on their budgetary performance since they had little idea about what their budget was. The lack of information made planning for longer-term changes extremely difficult.

At the other end of the spectrum were POTWs with finance or budget departments that carefully tracked spending by many different areas. Managers in these programs did know how much funding they had, and the budget information generally allowed them to plan much more effectively. Nonetheless, even the more sophisticated budget systems had room for improvement. Four central goals of a budget system should be to:

- **Help programs balance repairs against capital replacement**. Some POTWs pay for large investments that will be used for multiple years out of a single year’s budget. This makes budget outlays “volatile,” fluctuating widely from year to year. Alternatively, private corporations (as well as some POTWs) use accrual accounting, where the cost of multi-year purchases is spread over the useful life of the asset. This approach is used for tangible assets, such as new digesters, as well as intangible assets such as a headworks analysis used to set local limits. When capital costs are annualized, managers can make better trade-offs between the cost of new equipment and the cost of repairing existing equipment.[2]

- **Provide program managers with spending flexibility across budget accounts and budgeting years**. Traditional budgets are “use or lose” affairs; any money left at the end of the year reverts back from the department to the utility or town. Use-or-lose systems provide little incentive for managers to save money one year to apply towards something more useful next year. Similar dynamics apply when budget line items are adhered to rigidly. By

[2] For a detailed description of this problem, see U.S. General Accounting Office, *Budget Issues: Budgeting for Federal Capital,* November 1996.

focusing managers on the *results* of their enterprise, budget flexibility can help managers spend available funds much more efficiently. Managers may be allowed to use saved funds in the next fiscal year, set up contingency accounts to fund unexpected needs, or apply funds more broadly to their needs than can be reflected in standard line item budgets.

- **Improve long-term planning and expansion**. Effective budgets should also allow managers to examine trends in spending patterns and to estimate spending in the future. Though estimates of future spending are rarely perfect, they can identify large changes on the horizon for which the POTW should begin planning immediately. For example, one Indiana POTW had been operating under an expired NPDES permit for over five years. Staff knew that their new permit would require substantial changes to their operations, but had never examined in detail what those changes were likely to be, how much they would cost, and whether there were alternative ways to achieve compliance that were less expensive.

- **Illustrate how changes in spending in one department will affect resource requirements in other departments.** A budget document solely for pretreatment might encourage pretreatment managers to cut back on inspections in order to meet the budget targets they've been given. Without an understanding of how such a cutback might affect the influent contamination levels, and therefore the costs of operating the POTW and disposing of residuals, department-level efficiency might lead to utility-level inefficiencies. This link between departmental action and implications across departments should be reflected in departmental budgets.

Linking Budgeting With Cost Accounting

Like budgets, cost accounting systems are designed to provide critical information to decision makers. Therefore, an important first step in setting up a cost accounting system is to compile a list of the types of management decisions the organization expects to make. Examples might include: when to expand plant capacity; what user fees to set; where to allocate limited inspection budgets; and what activities will most improve the quality of effluent.

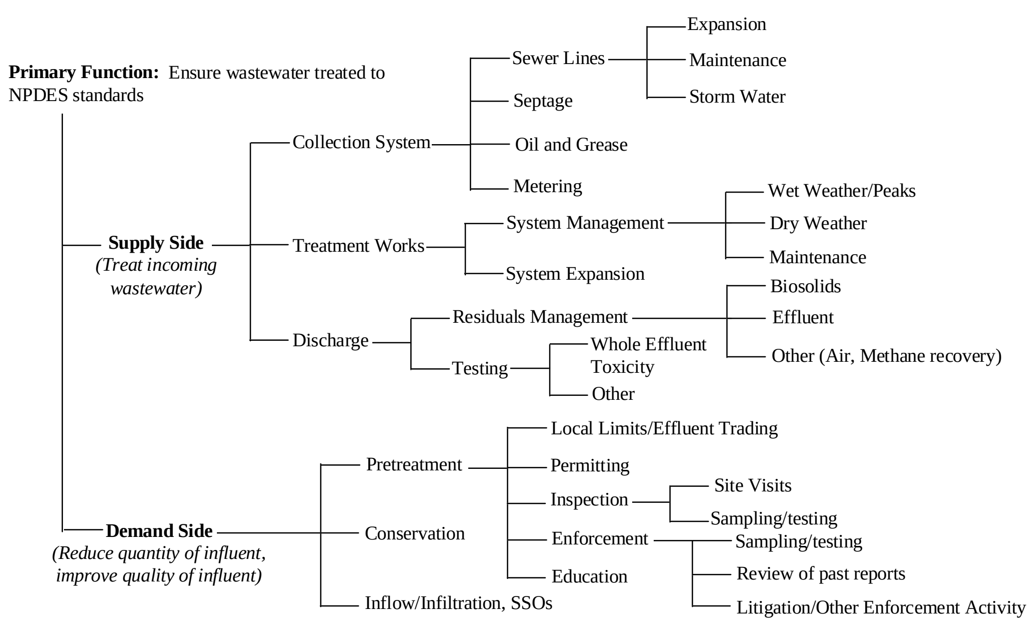
For organizations long accustomed to fairly rigid lines between departments, implementing a holistic cost accounting system may require a bit of work. Rather than grouping costs by topic (e.g., information systems, legal, laboratory) as many budgets do, cost accounting systems should delineate the core *activities* of the organization. The primary function of a wastewater treatment plant (WWTP) is to protect human health and the environment by treating wastewater to safe standards (as defined by each plant's

National Pollutant Discharge Elimination System, or NPDES, permit). To support this primary function, WWTP core activities might include supply-side functions such as collecting wastewater from discharge points and treating it to meet permitted discharge levels. On the demand-side, the plant could work to manage influent quality, quantity, and timing through its pretreatment, conservation, and inflow and infiltration programs. Each of these areas would, in turn, have subactivities associated with the broader function. For example, collecting wastewater would involve broader issues of managing the collection system, including sewer lines, seepage, oil and grease, and metering. Exhibit 1-1 outlines these major and sub-functions.

Detailed activities of the POTW are not shown in the chart, but are important in assessing the full cost of a particular activity. In fact, completing a task within any of

Exhibit 1-1

WASTEWATER TREATMENT PROCESS OVERVIEW



Cross-cutting functions: Management and Information Systems, Legal, Laboratory, Billing, Human Resources, Management/Administration, Finance (raising debt, budgeting, managing accounts payable and receivable).

these areas could require the use of resources from a variety of POTW departments, for example, billing or finance. Cost accounting will help managers track what resources are required to complete a particular task, such as permitting a large industrial user, and how much those resources cost the POTW. Linking the details of how much time and resources are required from all parts of the organization in order to, for example, permit an industrial user or expand a lateral collection line, is called *process mapping*. Creating process maps can be time consuming and expensive. Thus, gathering this information is only cost effective if it helps the POTW operate more efficiently and effectively. Whereas cost accounting answers the question "How much does it cost us to do activity *x* or to make product *y*?" process mapping can be used to determine *why* certain products or processes are expensive, where there are inefficiencies (e.g., data needs to be manually transferred multiple times), and how the activity might be streamlined to make it more efficient. The goals of a cost accounting system should be to:

- **Inform managers and staff**. This is the primary function of a cost accounting approach. The system should give managers and staff information on the cost of performing core activities and help managers evaluate the tradeoffs associated with different management strategies.

- **Illustrate the basic activities of the organization.** The process of shifting from budget line items to activity-based measures should help managers define the core functions of the organization in a consistent way and communicate these core functions to other staff.

- **Link activities with costs.** By linking specific activities with the resources required to complete them, the POTW can get a much clearer picture of the costs and benefits of particular service delivery approaches.

- **Reduce the magnitude of "overhead" expenditures.** Many organizations have a substantial percentage of their operating costs lumped into a general budget category called "overhead" or "administration." In reality, many of the activities allocated to these accounts support services to POTW staff and operations. A central goal of activity based costing, discussed in more detail in the next chapter of the report, is to link overhead costs with the activities they support so that managers can see the total cost of specific goods and services provided.

- **Illustrate cross-departmental links in service delivery.** Departmental lines often group similar functions in an organization (legal, personnel, laboratory, etc.) Day-to-day activities, however, regularly draw on resources from a variety of departments. Cost accounting systems need to reveal these links to help managers make sound decisions for the enterprise as a whole.

Once in place, a cost accounting system can:

- Demonstrate cost effective ways to reduce system costs, optimize resource allocation, and prioritize activities towards achieving a particular goal (e.g., environmental improvement or cost reduction).

- Illustrate the economic value of pretreatment; evaluate spending on pretreatment versus treatment at the POTW and on supply-side management versus demand-side management.

- Justify increases in charges to particular customers or municipalities and decreased charges to others.

- Provide the information needed to negotiate terms for interjurisdictional agreements, network expansion, or industrial user (IU) permits.

- Identify areas of poor resource utilization within the utility and help to rationalize system capacity.

- Help managers evaluate alternative mechanisms of service provision (e.g., in-sourcing, outsourcing).

Steps Towards Improved Budgeting and Cost Accounting

While the basic tools for improved budgeting and cost accounting are consistent across organizations, the goals of implementing improved systems must be tailored to the specific needs and circumstances of each POTW. Managers need to invest adequate time up-front to ensure that the questions a new budgeting and cost accounting system answers are the questions that are most important to them and their organizational health. Some general steps one can take towards improving these systems are presented below. These steps include both strategic, implementation, and evaluative components.

Strategic Components

- **Determine key measures of success.** As stated above, it is critical to focus measurement on items that are central to the organization's mission. These measures can be both financial and non-financial. However, even non-financial measures, such as "reduce copper loadings by 50 percent" can be more saleable if an economic component is added. For example, "reducing copper loadings by 50 percent will improve recreational fishing in our discharge river, boosting tourism."

- **Determine key decisions needed to achieve success.** What milestones are necessary in order to achieve goals? Do key strategic decisions need to be made now to facilitate reaching these goals? For example, if reducing metals loadings is a central goal, improved data on loadings might be a milestone, with this improved data integrated into a cost accounting system that allocates the excess costs of these loadings back to the sources of problem metals.

- **Develop a list of core activities of the organization**. If budgets are to be activity based, and new cost accounting systems are to allocate costs onto specific activities, work needs to be done up front to insure that all managers define the core activities of the POTW in roughly the same way.

- **Determine ground rules.** The very purpose of improved cost accounting is to identify areas of inefficiency within the POTW. There are winners and losers with these discoveries. For example, the importance of pretreatment in reducing total POTW costs may be highlighted. Alternatively, some departments may appear inefficient or redundant under the new method of assessment. If people are afraid they will be demoted or fired based on the results of the system, they will not participate in the implementation phase, and their knowledge of POTW processes will not be shared. One possible ground rule to address these concerns is a "no layoff" policy.

Implementation

Strategic issues help to determine what the improved budgeting and cost accounting system should accomplish, and to obtain initial buy-in from plant staff. Implementation is where these decisions get translated into organizational changes:

- **Accrual accounting.** Annual costs for capital spending is a very important input into a cost accounting system. Organizations that now pay for multi-year purchases out of their current budget need to implement techniques used in the private sector to measure capital services, as described below in the section on capital budgeting.

- **Cost accounting.** Using annualized capital costs and other spending information, the POTW will need to implement an activity-based costing system (also explained in the next chapter) to better allocate costs to the activities/customer classes that drive those costs.

- **Changes to budgeting rules.** Where rigid budgeting rules restrict saving funds from one year to the next or applying unused funds from one line item to another (where it is more needed), modifications are in order. Changing budgeting rules provides additional flexibility to department managers, but requires utility managers to be able to evaluate the *results* of departmental efforts. Performance benchmarking may be useful in this regard, enabling managers to track trends over time and compare performance with external organizations.

- **Changes in budget presentation.** Once costs are tracked by activity, it may make sense to present budget data by activity as well. This presentation will provide a more useful picture of where resources are being used than do current topically-organized budgets.

When implementing any of these tools, managers should consider the costs and benefits of doing so. Substantial increases in administrative complexity and costs make little sense if gains in efficiency and understanding are small. On the other hand, care should be taken to evaluate the costs and benefits of the transition over a relatively long period. Difficult changes may increase complexity in the short term but greatly enhance POTW operations once they are in place.

Evaluation

Cost accounting and budgeting are tools for better decision making. How well are they working? Are decisions improving over time? How are managers using the information these systems give them to do their jobs better? Periodic evaluation of both these tools and the POTW's operations is important to build into the accounting/budgeting system from the outset. Performance benchmarking can be useful in measuring improvement over time. Annual reviews of improvements, as well as periodic interviews with staff at various levels of the organization, is important for garnering the type of feedback that will enable managers to improve the systems over time.

To facilitate the implementation process, the next chapter provides a more in-depth introduction to the analytical tools needed for improved cost accounting and budgeting.

2. OVERVIEW OF TOOLS

This chapter provides an overview of a number of tools that POTWs can use to implement improved budgeting and cost accounting. Books are written on each of these tools; the information here should be viewed as a general introduction. The tools fall into three main categories: determining the cost of service, evaluating cost impacts of changes in the operating environment or service mix offered, and evaluating program efficiency.

- **Determining the cost of service.** The basic element in making sound decisions within the POTW is having accurate information on how much it costs to provide particular services to particular customers. Two tools for this purpose are discussed below: *capital budgeting* and *activity-based costing (ABC)*. Cost data must be supported by solid underlying scientific data as well, such as that on headworks loadings.

- **Evaluating cost impacts of changes.** Measuring the cost of service helps managers see which activities are more or less costly. One additional tool, *resource pricing* (also referred to as *shadow pricing*) can help the organization identify parts of existing operations that have extremely large cost impacts and estimate savings associated with operational changes. Often, these areas are bottlenecks in the system: a single resource that impedes efficient use of much of the rest of the plant. Resource pricing, in conjunction with the cost accounting system, can be used to evaluate competing options, such as increasing system capacity versus trying to reduce demand for existing capacity.

- **Evaluating program efficiency.** How well is your program providing wastewater treatment services? Two useful tools are *Process Mapping* and *Benchmarking*. Process mapping helps illustrate the complexity of seemingly simple functions within the organization and provides useful insights on how those processes might be simplified. Benchmarking, in which aspects of operations are compared to those conducted within other organizations, can be a useful tool in identifying areas for improvement within the utility.

Capital Budgeting

A fundamental concept of accounting is the matching of costs to the period over which benefits associated with those costs are received. When this is not done, managers are unable to assess their cost of providing goods and services (vital in order to decide what goods and services make sense to produce). From this need, costs have been divided into operating expenses and capital expenses. Operating expenses encompass costs that generate benefits in the current year.

Capital costs, such as new equipment or plants, create a stream of benefits that span multiple years. These multi-year benefits need to be annualized so that the portion of the benefit stream in any one year can be estimated.

Capital budgeting accomplishes two important functions. First it, annualizes capital spending, allowing capital to be compared to single-year purchases and to be included in a cost accounting system. This process is fairly mechanical, incorporating the cost of the purchase and the expected service life into an annual expense. In reality, however, capital purchases lock an organization's resources into a particular purchase for many years. Although annualized capital costs are useful indicators of the annual cost of capital services, the decision in year one to make the purchase is thereafter, for the most part, irreversible. For example, expanding the collection system to a new industrial park is a sunk cost. The money is gone even if no industries decide to move in, as one mid-Western POTW found out. The long-term nature and large expense of these investments requires that the decisions be made carefully. This is the second strength of capital budgeting: it provides a standard basis of comparison for alternative capital purchases. For this reason, many organizations have a separate capital budget that shows only capital purchases to help managers choose among many suggested options.

Calculating a Charge for Capital Equipment

To calculate an annual charge for a capital purchase (let's assume a new digester), the plant first groups all expenses associated with the design, purchase, and installation of the digester into a single account. Expenses that support this capital asset, even labor, are *capitalized*. If particular items are improperly excluded from the cost of an asset, the capital will seem less expensive than it really is. Consider the following common issues:

- *Financing Costs.* The asset cost should also include the cost of financing the capital, as this is often a large portion of the total cost of the asset. This cost may be visible and easily included if the city issued a bond to pay for the new investment. However, even if the town decided to pay for the asset outright, out of a single year's tax collection, it still makes sense to impute a financing cost to reflect the lost opportunity to use this money in an alternative way. In private firms, this imputed interest is referred to as "hurdle rate," the return below which a capital purchase can't be justified because it diverts funds from more productive uses.[1]

- *Incorporate life-cycle costing.* If current activities create future costs, such as decommissioning or remediation, these need to be allocated to the current product/process and accrued over its operating life.

[1] Note that a hurdle rate will generally include not only the break-even return necessary for the firm to pay for the capital it is investing, but a profit margin above that level as well. Since most POTWs are publicly-owned and do not earn profits, the imputed interest rate will likely be somewhat lower than if it would be for privately-owned plants.

- *Replacement Costs versus Historical Costs*. The use of replacement cost pricing violates the cost of service principles normally used in rate setting at POTWs. However, if replacing a capital asset is much more expensive than it was to install it in the past, the use of historical costs in estimating the rates will encourage overuse of the capital. Capital charges based on replacement cost will encourage all current users to constrain their use of the capital, delaying the time when capital expansion -- at the much higher price -- will be necessary.[2] Note that replacement costs can be higher for a number of reasons, including inflation, the loss of government-subsidized financing options, or new technical requirements.

The sum of these costs becomes the *cost basis* of the asset that is depreciated. The purpose of depreciation is to reduce the value of the capital asset over time, as its useful service life is exhausted. Thus, the depreciation period should be set equal to the estimated service life.[3] For simplicity, let us assume that the asset wears out evenly over time (known as straight line depreciation).[4] If the digester was expected to last 20 years, than 1/20th of the total cost basis would be recovered from users in each year. Annual costs (or revenues) associated with the asset would be added to the capital charge in order to obtain a total cost of a capital asset that should be recovered from customers. Annual costs, often referred to as operations and maintenance costs, include such items as energy and repairs. Revenues might include by-product sales or reuse (for example, methane recovery and reuse from a digester) that should be deducted from the total annual cost.

Protecting Capital Recovery

The purpose of capital budgeting is to accurately estimate the cost of capital services to managers and customers. In this way, rational decisions can be made about when to replace old equipment with new, and what the proper mix between capital and operating costs is. Users can be

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[2] This occurs naturally in competitive markets, where the market price is equal to the *marginal* cost of the least-efficient producer still able to stay in business. Since POTWs don't compete with each other to treat wastewater, marginal cost rationing needs to be added artificially.

[3] Private firms depreciate assets as quickly as allowed under the tax code in order to reduce their effective tax rates. For pricing capital services, however, the assets should be depreciated over the service rather than the tax lives, as this is the best approximation of the annual cost of using the capital.

[4] There are a variety of other depreciation methods, all of which generally depreciate a higher percentage of the asset value in the early years. The actual pattern by which an asset depreciates in value will vary by asset type.

charged the true cost of the capital they use, giving them an incentive to use the capital efficiently. POTWs will be able to accrue funds steadily so they can finance replacement capital at the end of the old capital's service life.

Unfortunately, this system begins to break down in the real world politics of sewage treatment. No matter how "perfect" the capital charges are, if the funds collected for capital replacement are diverted for other uses, the plant will not make efficient capital allocation decisions. While this problem is relatively common in WWTPs, our limited sample of site visits suggests it is more acute in municipal systems than in special sewer districts. Funds collected from within the POTW for capital replacement are diverted to the general fund of the municipality to meet some immediate need in another part of the budget.

Linking collections to specific uses is important if the system is to provide proper incentives. For example, if plant managers know that capital replacement funds will not be available when they need them, they begin to "game" the budget system to buy capital equipment whenever they can obtain funds, rather than when they really need it. The type of capital equipment they buy may be driven as much by the amount of funds they can obtain in a given year as by the problem they are trying to address.

Municipalities have adopted a number of techniques to minimize the problem of funds diversion. All of these techniques restrict how capital recovery funds may be used, reducing or eliminating the latitude for town officials to divert the monies for other uses. Some examples:

- **Lease or outsource.** For utilities where the political process makes accruing for capital purchases and replacement nearly impossible, leasing equipment or outsourcing functions can bypass some of the problems.[5] Once in place, funds for wastewater treatment no longer go to the city, where they could be diverted, but rather to the lessor or private provider. This type of decision (outsourcing more so than leasing) has implications

[5] We encountered a number of smaller POTWs where strategic decisions with any financial implications had to be approved by a utility board, comprised of many members of Significant Industrial User (SIU) companies. These members sometimes use their leverage to impede effective POTW enforcement of discharge violations or to block improvements in staffing or equipment that would have increased the POTW's enforcement capabilities. Leasing or outsourcing specific functions is unlikely to solve these conflict of interest problems, as the utility boards can still intervene to block the initial leasing or outsourcing decision.

on other aspects of POTW operation, so should not be undertaken lightly.[6] In addition, unless outsourcing contracts are written carefully, the private provider may have disincentives to long-term capital investment as well.[7]

- **Bond financing.** By issuing bonds for capital projects, the POTW creates a legal obligation that funds from users support bond repayment to an external agent. Bond financing is commonly used by POTWs for large capital expansion. Ideally, the bond life is matched to the service life of the asset being financed. In this circumstance, annual bond repayments are a fairly good indicator of the cost of capital services. In reality, bond life is generally driven by interest rate conditions rather than service life, so may be a weak proxy for the cost of specific capital services.

- **Revolving Funds.** Revolving funds are often run by external agents, although they can also be run by the utility. A loan is made to the POTW for a specific project, then repaid over time from user fees. The up-front costs of bond issuance, however, make bonds a more effective tool for large scale capital projects; revolving funds are economic at a lower level of funding.

- **Internal Accounts.** Some utilities have set up internal accounts for asset replacement funds. Collections go into these accounts and are somewhat protected from being "raided" by other parts of the municipality. Funds are earmarked for specific purchases, and do not revert back to the general fund at the end of each budget cycle as do most unspent departmental funds.

- **Working Capital Funds.** Also an internal account, working capital funds operate as a savings account for new capital purchases. Contributions by managers are voluntary, rather than based on mandatory capital charges. However, the approach provides managers with flexibility to do multi-year planning.[8]

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[6] For an in-depth discussion of issues associated with POTW privatization, see AMSA, *Evaluating Privatization: An AMSA Checklist*, 1996.

[7] The payback on major capital investments can be five to ten years or more. If a private operator has only a five year operating lease, it will choose not to invest in assets with long-term paybacks unless absolutely necessary.

[8] U.S. General Accounting Office, *Budget Issues: Budgeting for Federal Capital*, November 1996, p. 52.

To be effective, internal accounts and revolving funds must allow managers to purchase and sell assets as need dictates. Positive balances should earn interest if these funds are used in the interim for any other purposes. Managers also need to be free to implement replacement cost pricing in order to send the proper price signals.[9] Because these systems reduce the power of central utility boards to control successive spending (i.e., after the initial capitalization of the fund or account), the central boards sometimes resist the implementation of these approaches.

Activity-Based Costing and Wastewater Treatment

Activity-based costing (ABC) is a simple but powerful idea: allocate costs to processes, products, or projects on the basis of the activities that generate these costs. To do so, one must group spending by *activity* rather than by *department,* as is often done. When ABC is successfully implemented, many costs now termed "overhead" are linked to the activities that generate them, and are allocated accordingly to products, customers, or other cost "objects." The end result is cost information that provides accurate and complete costs for a particular area of business activity. The full costs of generating particular products or services can be quite surprising. Many private sector firms have discovered they were selling products for less than it cost them to make, once support services and capital requirements are included.

This type of an outcome is possible because the intensity of demand for support services and infrastructure varies widely by customer and time period. Wastewater treatment abounds with examples of this type of behavior. Additional capacity may be needed at the plant to handle seasonal dischargers, either due to industry cycles or tourist peaks. Where infrastructure is old or poorly built, large inflow and infiltration during rainstorms can dramatically increase capacity requirements at the treatment plant. In terms of differing demands on support functions, certain industries -- such as those in non-compliance -- will require a much higher level of laboratory support and inspector time. Large industries may require more time to permit than smaller, less complicated ones. These are but a few examples. Overhead costs, and costs in general, are driven by variety, complexity, and activities.[10] Variety reduces opportunities for achieving economies of scale and adds complexity. Complexity increases opportunities for mistakes and increases the time spent trying to prevent mistakes. The more activities that need to be done to create a saleable product, the higher the costs are likely to be.

Cost distortions are more likely when:

- An enterprise provides both high- and low-volume services from the same facility.

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[9] Ibid., pp. 44-50.

[10] Michael Ostrenga, *et al., The Ernst & Young Guide to Total Cost Management,* (NY: John Wiley & Sons, 1992), p. 38.

- A single plant provides services to different customers of varying complexity.

- Some dischargers require higher standards of treatment, or higher treatment capacity, than others.

Mechanics of Activity-Based Costing

ABC involves linking *resources* to *activities* to *cost objects*. Resources include the basic inputs to production: time, labor, capital, and energy, all of which cost money. These resources are allocated within an organization to support particular activities: inspecting a discharger, testing an effluent sample, preparing and mailing a customer's bill. These activities, in turn, are conducted for the benefit of the "cost object." A cost object is a rather bland term that describes the goal for which resources are being used. Most commonly, cost objects are products or services. Service to a particular type of customer (a customer class) can be a useful cost object as well.

Unlike a factory, which might produce seven varieties of blue jeans, WWTP output is more difficult to define. At a most basic level, the plants produce clean water and safe biosolids. However, the plants provide a host of services to support this output, and these services are not at all uniform. For example, treatment of wastewater is a different service for different types of customers. The service required by a significant industrial user is quite different from that required by a small residential customer. Even within the SIU, a range of services are provided depending on the type of industry and the nature and timing of the discharge. By tracking these distinctions, ABC provides managers with new insights into their operations.

The overall process of ABC is presented in the event-chain shown below. Each element of the chain is described in turn.

COST MEASUREMENT → COST ALLOCATION → TRUE COSTS OF PRODUCTS/SERVICES → BETTER DECISIONS

<u>Cost Measurement</u>

Allocating resources to activities requires that the organization accurately measure costs. For many expenditures, this data can be obtained from WWTP's general ledger, which lists each purchase or payment. Capital costs must be adjusted to reflect the real cost of using scarce capital resources, as described under the capital budgeting section above. Labor costs, often grouped into a single expenditure, need to be tracked based on what activity the time was spent on. For some organizations, implementing a system of tracking time (such as by using timesheets) can be a big change.

Cost Allocation

Costs are grouped into *activity cost pools*, which are simply the summation of all expenditures related to a particular organizational activity. The allocation of costs involves two important decisions: what the activity cost pools should be, and how general costs should be allocated among cost pools.

- **Defining Activity Cost Pools.** There is a trade-off between more refined activity cost pools (which allow costs to be allocated more precisely) and the cost and complexity this proliferation adds to the organization. General categories are usually best unless compelling information indicates costing would be much improved through additional categories.

- **Assigning Costs.** Costs must be assigned from activity cost pools to cost objects in a manner that reflects the behaviors that actually drive the costs (referred to as *cost drivers*). Thus, costs should be charged to a customer or product directly whenever possible -- for example, if a specific person was hired only to service a particular customer. When this is not possible, costs should be allocated based on the level of service provided, such as the use of labor or machine hours. Only when data exist with which to estimate the degree of workload created by a particular product or customer should costs be allocated based on a general volume measure (e.g., share of revenues or production volume).

"True" Costs of Products/Services

The full cost of a cost object is equal to the sum of its direct costs plus a fair share of applicable indirect costs. Direct costs include materials, labor, energy, and capital that can be directly attributed to creating or servicing a particular cost object, such as an industrial discharger. While all POTWs must have their rates approved, for which they conduct a cost-of-service study, the resultant rates rarely represent the true costs of providing services to particular customers. Much of the problem lies in how costs are assigned to particular cost object. Activity-based costing can greatly improve the accuracy of costing. While the results will not be the "true" costs (as judgments are always required in assigning indirect costs), they will provide customers and managers with substantially better cost information on costs with which they can make decisions.

Implementing an ABC System at a WWTP

Implementing an ABC system can be an extensive undertaking. An important first step is to think critically about the desired outcomes of the endeavor. Is the goal to track specific services more closely? Specific service families? Specific customers? What types of decisions do you hope to make with the output from the system?

An activity-based costing system for a publicly-owned treatment work can focus less on product line profitability than would be required in such a system for a private firm. However, tracking the costs to serve particular types of customers is quite valuable. This information can help managers evaluate their current charges, focus their outreach and enforcement, and identify high cost activities within the POTW for streamlining.

Exhibit 2-1 below provides a hypothetical example of the cost of conducting a routine inspection at an IU. Activities required to conduct the inspection are broken down into the resources they use. The cost of these resources is then used to estimate the full cost of the inspection. The value of ABC is that it can demonstrate the often large impact that "support" functions have on the service provided. In this example, laboratory costs are particularly high.

The first step in most POTW cost of service assessments is to allocate costs to rather broad functional area cost pools. There is some variation across POTWs in terms of what cost pools are chosen. The functional areas outlined in Exhibit 1-1 could be used. Managers may decide initially to use fewer allocation pools, including such items as treatment, transmission, collection, disposal, billing, customer service, accounting and finance, and administration.[11] The Massachusetts Water Resources Authority (MWRA), a very large integrated utility, has additional categories such as public affairs, procurement, and human resources. These activities would likely be accomplished by a single person (or fractional FTE) at a small POTW.

Regardless of their exact categories, cost pools need to provide managers with their desired level of information without creating an undue information collection burden on their staff. It is important to note that not all functional areas are the same with regard to their contribution to direct and indirect costs. For example, most costs associated with wastewater collection and treatment are directly related to services provided to dischargers. Functions such as human resources or public information have a more indirect link. In terms of prioritizing implementation of activity-based costing, it is best to begin with large costs linked more closely to customers, as these are the areas where costing problems are most likely to distort discharger behavior.

Assigning costs to functional areas has traditionally been done within customer classes -- for example, residential, commercial, industrial, institutional, other government utilities, and customers outside the city.[12] In many situations, customer class is not the best allocation base, as important cross-subsidies may remain. POTW managers should think carefully about cost drivers in determining how to allocate particular costs. To the extent costs can be allocated to particular dischargers rather than to customer classes, this should be done.

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[11] George Raftelis, *Comprehensive Guide to Water and Wastewater Finance and Pricing, Second Edition,* (Ann Arbor, MI: Lewis Publishers, 1993), p. 178.

[12] Ibid.

Exhibit 2-1

Hypothetical Example of Activity Based Costing

Cost Object: Routine Inspection at ACME Eraser Company

Activities	Resources Required	Possible Costing Basis	Cost Allocation Units	Rate	Cost
Pre-Inspection Data Review	-Clerical time to pull files	Labor time	0.2 hours	$12.00	$2.40
	-MIS Resources for data storage and access; and for scheduling inspections	Computer time	0.5 hours	$4.93	$2.47
	-Review by inspector	Labor time	0.5 hours	$17.00	$8.50
	-Phone contact to schedule inspection	Labor time (clerical) + telephone time	0.2 hours		$3.00
Travel to and from Site	-POTW vehicle, gas, repairs, insurance	Average charge per mile traveled	13 miles	$0.31	$4.03
	-Inspector travel time	Labor time	0.4 hours	$17.00	$6.80
	-Sampler travel time	Labor time	0.4 hours	$12.00	$4.80
Inspection of Site	-Inspector time	Labor time	1.5 hours	$17.00	$25.50
	-Assistant time	Labor time	0 hours		$0.00
	-MIS costs for expert system used on inspections	Number of inspections	1	$22.50	$22.50
Sampling	-Chemicals and supplies	Direct costs		$35.00	$35.00
	-Sampler Time	Labor time	0.4 hours	$12.00	$4.80
Analyzing Samples	-Lab technician time	Labor time	1.2 hours	$17.00	$20.40
	-Machine time (includes all costs related to purchase and upkeep of machine and rental of space to house it)	Pro-rated share of total cost of particular equipment used	1.0 hours	345.00	$345.00
	-Chemicals and supplies	Direct costs		43.00	$43.00
	-Residual management and disposal costs	Direct costs		17.00	$17.00
	-MIS costs for Laboratory Information Management System	Transactions processed	3 samples	5.81	$17.43
Post-Inspection Write-up	-Inspector time	Labor time (inspector)	0.5 hours	$17.00	$8.50
	-Manager review	Labor time (manager)	0.25 hours	$23.00	$5.75
	-Data verification and entry	Labor time (clerical)	0.4 hours	$12.00	$4.80
	-Follow-up communication with industry	Labor time (inspector)	0.3 hours	$17.00	$5.10
	-MIS costs	Computer time	1.0 hour	$4.93	$4.93
	Total Cost to Inspect ACME				**$591.71**

Exhibit 2-1 (continued)

Summary of Cost Factors

	Rate
Labor Rates ($/hour, including fringe benefits)	
Inspector	$17
Sampler	$12
Manager	$23
Clerical	$12
Lab Technician	$17
Computer Time	
Laboratory Information Management System (Hardware and software)	
Total Cost/Year	$25,000
Transactions Processed/yr	4,300
Cost/transaction	$5.81
General MIS Support (other than LIMS and project-related support)	
Total Cost/Year	$74,000
Number of staff-hours used	15,000
Average cost/MIS hour	$4.93
Expert System for Inspectors	
Total annualized cost	$9,000
Number of inspections/year	400
Cost/inspection	$22.50
Telephone System	
Long-distance	direct billed to projects
Local calls	
Total costs/year	$950
Total minutes of calling	19,000
Avg. cost/minute	$0.05

Exhibit 2-2 illustrates the cost drivers for key functional areas of the POTW. Similar services can have very different cost drivers, depending on whether they are baseline versus peak capacity, or capital versus operating costs. Some general rules have been used in developing the exhibit:

- **Minimum size rule.** The minimum scale of operations required to service an average customer is defined as the "baseline" system, for which the costs are spread equally across customers. This minimum size needs to be determined by each POTW, but should incorporate two important considerations. First, variability in the "average" discharge suggests that the minimum size should be slightly higher than the average to handle standard deviations in discharges. Second, given the large costs and difficulty of retrofitting POTW infrastructure if it is undersized, a prudent baseline system should also include some level of oversizing to provide flexibility, the cost of which would be shared among all customers. These caveats aside, the additional capacity required should then be allocated among specific customers (or customer classes) based on their demand for the incremental services.

- **Disaggregation of service provided.** By breaking services into smaller units, it becomes easier to differentiate the cost of servicing different customers (this process is often called "unbundling"). Collection costs are a good example. In very large POTW systems, the sewer line distance and the pumping costs can vary widely across customers. Unit costs can be higher not only due to distance, but due to utilization of particular portions of the network as well. With disaggregated costs, the POTW can calculate the carrying charge from any particular location fairly easily, and use this information in rate setting, to identify areas for decentralized treatment, or to promote growth in order to increase utilization of infrastructure within particular regions.

- **Polluter pays principle.** Wherever possible, the dischargers of constituents that reduce the quality of residuals (and hence their market value) should bear the financial burden of those lost revenues.

Support functions, such as administration or finance, will generally require some use of process mapping in order to estimate the costs associated with particular services to customers or customer classes. Process mapping is described in more detail at the end of this chapter.

Exhibit 2-2

ALLOCATION OF KEY POTW COSTS

Cost	Allocation Base	Rationale
Collection System		
Baseline collection system	Customer	Size of pipes and installation cost of collection system for average sized user is driven by number of users.
Incremental sizing: laterals	Flow: non-coincident demand method	Lateral sizing determined by individual peaks of each customer.
Incremental sizing: trunklines and pumps	Flow: coincident demand method	Trunklines can average differing peaks by discharges. Thus, best allocation is based on peak flow level for the POTW.
New collection lines	New customers	The full cost of extending the collection system should be borne by the beneficiary industries or neighborhoods. POTW can set up a longer-term payment so that future users in the new zone also pay a portion of the cost.
Pumping: operating costs	Discharge quantity	Each pumping station can have a charge that is a function of influent pumped. Dischargers farther from the plant may go through a sequence of pump stations, and thus will pay a higher total pumping fee.
Fats, oils and grease (FOG) collection: baseline program	Customer class	Base fees for setting up and operating an oil and grease program should be spread among all oil and grease dischargers equally.
FOG: enforcement and clean-out	Facility	Any incremental costs for inspection, enforcement, or damages (e.g., system clean-out) should be direct-charged to the facility. If facility can't be identified, charge should be borne by all FOG permittees.
Septage	Customer class	Base fees to set up a basic program should be reflected in permit fees to haulers. Incremental costs of handling specific loads should be charged directly to the hauler through a tipping fee (price per gallon or pound) and/or strength surcharge. In districts with multiple drop-off sites, the incremental costs might include location-specific surcharges for pumping costs.
Treatment Works		
Baseline capacity construction and maintenance	Customers	Using the minimal size rule, the baseline cost of providing the treatment plant should be borne equally by all dischargers.
Peaking capacity construction and maintenance - Large dischargers - Inflow and infiltration	Flow: coincident demand method, with surcharges for strength	Additional capital requirements driven by large dischargers, high strength wastes, and inflow/infiltration. Incremental costs of building and operating a larger facility should be borne by these causal agents, in proportion to their contribution to the problem. I/I charges may need to be prorated to certain zones of the system (e.g., specific towns) based on their contribution.

Exhibit 2-2

ALLOCATION OF KEY POTW COSTS (continued)

Cost	Allocation Base	Rationale
System operating costs	Flow: quantity and strength	Variable costs driven by the amount and strength of wastewater treated.
System Expansion	Flow: coincident demand	So long as treatment costs are appropriately allocated among peak and non-peak users, system expansion costs should be borne by all users, not just new ones. Only in this way will demand for total capacity be properly rationed.
Discharge Management		
Biosolids and effluent: baseline program	Discharge quantities	All dischargers contribute to residuals requiring management. Baseline cost of management, assuming highest grade biosolids and effluent, should be borne by all dischargers.
Biosolids and effluent: incremental management costs	Dischargers of constituent(s) of concern	If there are incremental costs of having to landfill or incinerate biosolids, or of not being able to resell effluent, they should be borne by the dischargers that created that need, based on their contributory share of that constituent.
Compliance testing	Discharge quantities	While some dischargers may contribute to the need for compliance testing of influent and effluent more than others, most of the testing is done to comply with the Clean Water Act. Thus, allocating costs to all customers based on quantities of discharge requiring treatment is a simply and fairly accurate method.
Pretreatment		
Local limits setting	Flow quantity	Baseline requirement of the POTW. While contributions of constituents of concern may vary by discharger, all customers (including residential) contribute to loadings.
Permitting and Inspection	Time and materials	Effort to permit and inspect IUs various by facility. Costs, including associated support functions, should be allocated based on effort.
Enforcement	Time and materials	All enforcement costs should be allocated to the enforcement target for recovery during the case. Enforcement costs for cases that are not pursued or lost should be allocated across IUs.
Education/Outreach	All IUs	Since topics are likely to change year-to-year and many of the targets are likely to be smaller businesses, it probably makes sense to spread this cost across all IUs based on flow.
Conservation Programs	Time and materials by customer class	Efforts to reduce discharge levels through conservation programs are similar to education and outreach expenses, although costs and approaches are likely to vary substantially across customer class.

Exhibit 2-2

ALLOCATION OF KEY POTW COSTS (continued)

	Cost	**Allocation Base**
Inflow and infiltration/sanitary sewer overflows	Discharger or zones of contribution	Charges for peaking capacity due to I/I were already allocated above to zones of contribution. Efforts to remediate I/I through special maintenance or upgrade programs to collection systems should also be borne by customers in the particular part of the system that is causing the problem and benefiting from the upgrade.
Cross-cutting Functions		
Laboratory support, human resources, administration, legal, finance	Time and materials	Costs should all be allocated to the various departments based on the actual time and materials spent providing services to them whenever possible. If links can be made to specific dischargers (as is often possible with laboratory tests), charges should be pro-rated to them.
Billing and metering	Customer class - fixed charge	Billing and metering costs are fairly fixed for a given size customer. Thus, the costs for each customer class should be estimated and then included in a monthly service charge that is independent of quantity discharged.
Debt Service	Pro-rated to purpose of debt	Recovery all capital related to collection and treatment infrastructure would include the financing costs.
Sources: Raftelis, 1993; National Association of Regulatory Utility Commissioners, 1989; MWRA, 1994; MWRA, 1997.		

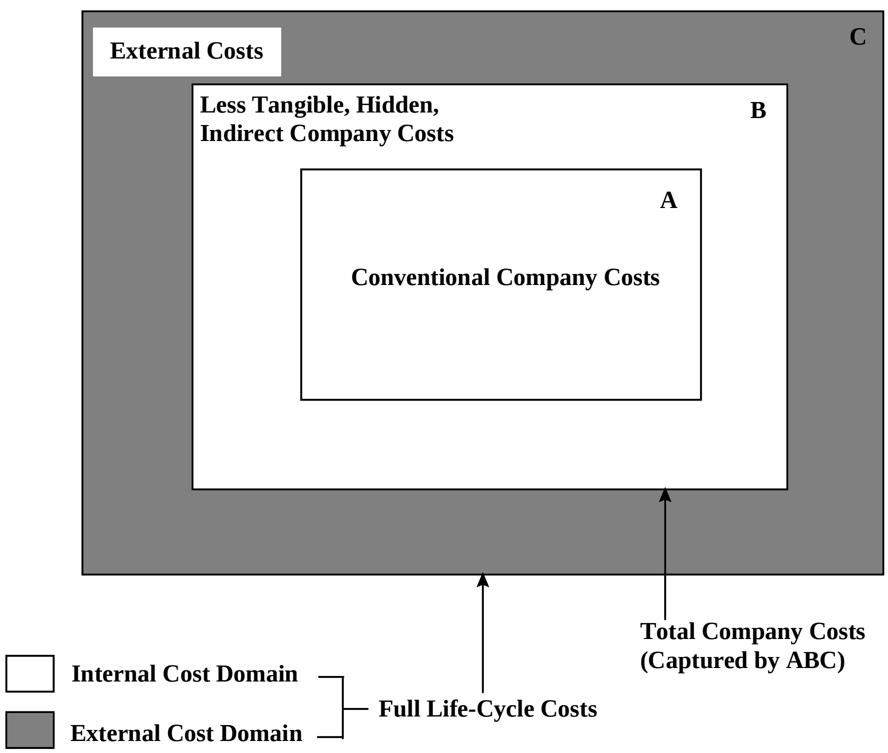
Caveats

This guidance provides a general overview of ABC applied to WWTPs. We draw on work done for electric and gas utilities on cost allocation, and encourage readers seeking more detailed information to examine that literature as well. Application of even relatively simple ABC systems can greatly improve the cost information that managers within the plant, as well as customers relying on the plant, use to make decisions. It is important to remember that ABC is a tool for decision making, not the determinant of a decision; interpretation of the results is always necessary to use this information most effectively. The following caveats help to place the information in context:

- **Externalities excluded.** Activity-based costing generally stops at the enterprise walls; external costs are not rolled into the calculation as is done with environmental accounting or lifecycle costing. As a result, the environmental costs of particular industrial discharges -- for example declining fish populations -- will not be picked up as a cost to be allocated to particular dischargers unless program managers expressly decide to do so.

Exhibit 2-3

BOUNDARIES OF ACTIVITY-BASED COSTING ASSESSMENTS



Source: Based on White *et al.*, 1995, p. 21.

- **Cost Rigidity.** Not all cost components are easy to reduce, even with the proper price signals. In the longer-term, more of the costs can be influenced than in the shorter-term. Thus, ABC signals are likely to be more valuable in rationing constrained capacity or sizing new capacity than in changing use patterns for infrastructure that is already in place but oversized.

- **ABC measures *average* costs, not *marginal* costs or market value**. Although ABC allocates costs based on which customers/services drive the demand for extra resources, the resulting cost allocation is an *averaging* of the incremental cost among users. For example, if handling peak flows in a collection system increases costs by 50 percent over the baseline, this 50 percent would be allocated across the users of that peak capacity. For existing capital infrastructure that is underutilized, ABC may suggest a higher-than-rational allocation of costs to particular users. In the collection system example, if there is spare capacity in both the collection and treatment system, charging a new user full ABC value would signal scarcity when in fact none is present. Resource pricing, which is a marginal analysis (and is described below), can be a useful supplement to ABC in situations such as this.

- **Cost of flexibility.** As noted above, flexibility, in the form of some surplus capacity at the time of construction, is generally a prudent strategy with large, difficult to modify, capital infrastructure. Managers need to interpret ABC information in such a way as to recognize the value of this flexibility.

<u>Resource Pricing and Debottlenecking</u>

Soda bottles have narrow necks that slow the flow of liquid. The narrower the neck, the slower the flow from the container. This analogy has been applied to factories where the output of the entire system is limited by the speed of the slowest part. If a POTW has a treatment capacity of 16 mgd, but the trunkline system pipes are so narrow that they can deliver only 5 mgd for treatment, much of the expensively built treatment capacity will sit unused. (In all likelihood, sewage will also be flowing out onto the streets or back into people's houses due to the lack of collection as well).

"Debottlenecking" expands the limited constraint, allowing the system to operate with a higher throughput. A logical solution to the above example would be to expand the trunklines to carry greater flow. This adaptation might solve the problem for some POTWs; for others, the bottleneck might simply shift from the trunkline to the laterals in certain parts of the service area. The laterals that are constrained may shift as well, depending on the production cycles of discharging industries, rainfall (due to I/I), or other factors.

This simple example illustrates two important points about the POTW system:

- Bottlenecks can "float" from one area to another depending on what problem is corrected and the current activity of the system.

- To eliminate all bottlenecks at once, one must examine the system holistically and model capacity constraints under various conditions.

Unused capacity in the treatment system can drive costs of treatment up substantially. For example, according to a recent survey by the Association of Metropolitan Sewerage Agencies (AMSA), the average POTW needed to pay $23.2 million in principal and interest per year, or more than $63,000 per day. The revenue requirements are substantial. In a 20 mgd plant, this translates to roughly 0.3 cents of debt service per gallon treated if the plant were running at full capacity, funds that are lost if constraints in the process prevent this capacity from being used. If the plant was oversized to handle storm surges, the cost per gallon could be substantially higher, affecting all users. Thus, it is important to eliminate bottlenecks to ensure that the expensive infrastructure put in place can be used effectively.[13] However, the desire to reduce wasted capacity must be balanced against the ease with which capacity can be expanded later. Thus, it is more important to have spare capacity in collection systems (which require digging up roads to replace) than in digester capacity, since digesters can be added one-by-one as demand for them rises.

Not all bottlenecks are as obvious as below-size trunklines. Any resource used in the plant can be constrained. If this constraint impedes the use of other assets, the constraint can be expensive indeed. Consider the case of skilled engineering labor. If the POTW is using all its skilled engineers to design the collection system in a new industrial park, staff may not be available to retrofit the aeration unit with more energy efficient fine bubble diffusers. Should the POTW managers pull engineers from the industrial park design and get them to work on the diffuser? The answer is not always obvious. In fact, it is in situations where the same asset (including skilled labor) can be deployed in many ways, or the expansion of a very expensive asset can be delayed via many alternative strategies, that resource pricing becomes most valuable.

Accurate resource pricing gives managers price signals that help them to decide the most effective manner to deploy scarce internal resources. Just as an expensive price for biosolids landfilling tells managers to look for less expensive options, so too do expensive internal prices on key resources, such as treatment capacity, help focus attention on ways to conserve that commodity. Resource prices determine the *opportunity cost* of using resources in one area as opposed to another. If we change one scarce resource to project 2 (installing the fine bubble

[13] For new construction or plant expansions, this means be sure that the capacity of the equipment installed is proportionate to what is needed in the other, connected, parts of the treatment process.

diffuser) from project 1 (designing the industrial park collection system), what will happen to POTW margins (revenues minus costs)? Will accelerated implementation of project 2 make the overall POTW system better or worse off than rapid completion of project 1?[14]

An undersized trunkline in the 10 mgd plant can illustrate how resource pricing works. The pipe sizing prevents 50 percent of the treatment capacity from working. This lack of trunkline capacity is the *constraint.* If the daily debt service on the plant is $63,000, the cost of leaving 50 percent of it unused is $31,500 per day (0.3 cents per gallon per day), or more than $11 million per year.[15] In industries with large fixed investments and linear processes (where all material flows through the same equipment), costs of bottlenecks can be enormous. The value of increasing trunkline capacity in this example would be roughly $1.10 per annual gallon of capacity.[16] That is, in this highly simplified example the resource price for expanding capacity in the trunkline is $1.10 per annual gallon. (The resource price for any input which is not constrained -- for example treatment capacity -- is always zero. This is because increasing the amount of this resource available will do nothing to increase plant output).

This cost information can be used in a variety of ways:

- If expanding the trunkline costs substantially less than $1.10 per annual gallon of capacity, and the lack of additional capacity is preventing flow from reaching the plant, expanding the line makes sense.

- If the plant has not yet been built and the cost information was gathered to help properly size the plant, the information helps managers see the cost of oversizing the treatment plant (or the cost of undersizing collection systems) and to plan accordingly. For example, if projected peak flows can be reduced for less than $1.10 per annual gallon (such as through I/I control), resource pricing helps to demonstrate that these alternative strategies are cost-effective.

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[14] Resource pricing evaluates technical constraints. There may be strategic reasons to continue with project 1 even if doing project 2 sooner would increase POTW margins. As with all of the tools described here, management insight is still required in order to make a sound decision.

[15] This is a rough approximation. In reality, not all of the capacity will be used even in well-balanced plants, and the annualized cost of capacity may not be equal to the debt service. In addition, costs other than debt service would also be spread over the new capacity, increasing the value of removing the constraint. Finally, were the POTW a private entity, the cost of unused capacity would not be higher costs, but rather forgone profits, usually a higher figure.

[16] Equal to 0.3 cents per gallon per day multiplied by 365 days/year.

Implementing a comprehensive resource pricing system is much more complicated than this simple example. Linear algebra programming is used to map out the many constraints in the POTW systems and the goal to be maximized (known as the *objective function*). Equations are set up to describe the various outputs, their contribution margins, and their production constraints. However, unlike industrial processes such as petrochemical plants and oil refineries that have scores of product output options, POTWs provide a much smaller diversity of services. Therefore, applying the concept of resource pricing to key assets (especially those shared by multiple municipalities), even in a simplified way, can help to greatly improve system efficiency.

Process Mapping

Process mapping is a systematic tracking of physical processes, key task flows, and information flows within an organization. The purpose is to step back from day-to-day activities and try to track what resources are actually used in providing a certain type of service or product. A process map is a picture of the variety, complexity, and activities that commonly drive up costs. Each step of the map is a resource input, to which units (labor hours, machine hours, material inputs) can be attached. By monetizing these inputs using information on the cost of these inputs, the total cost of providing the cost object can be estimated.

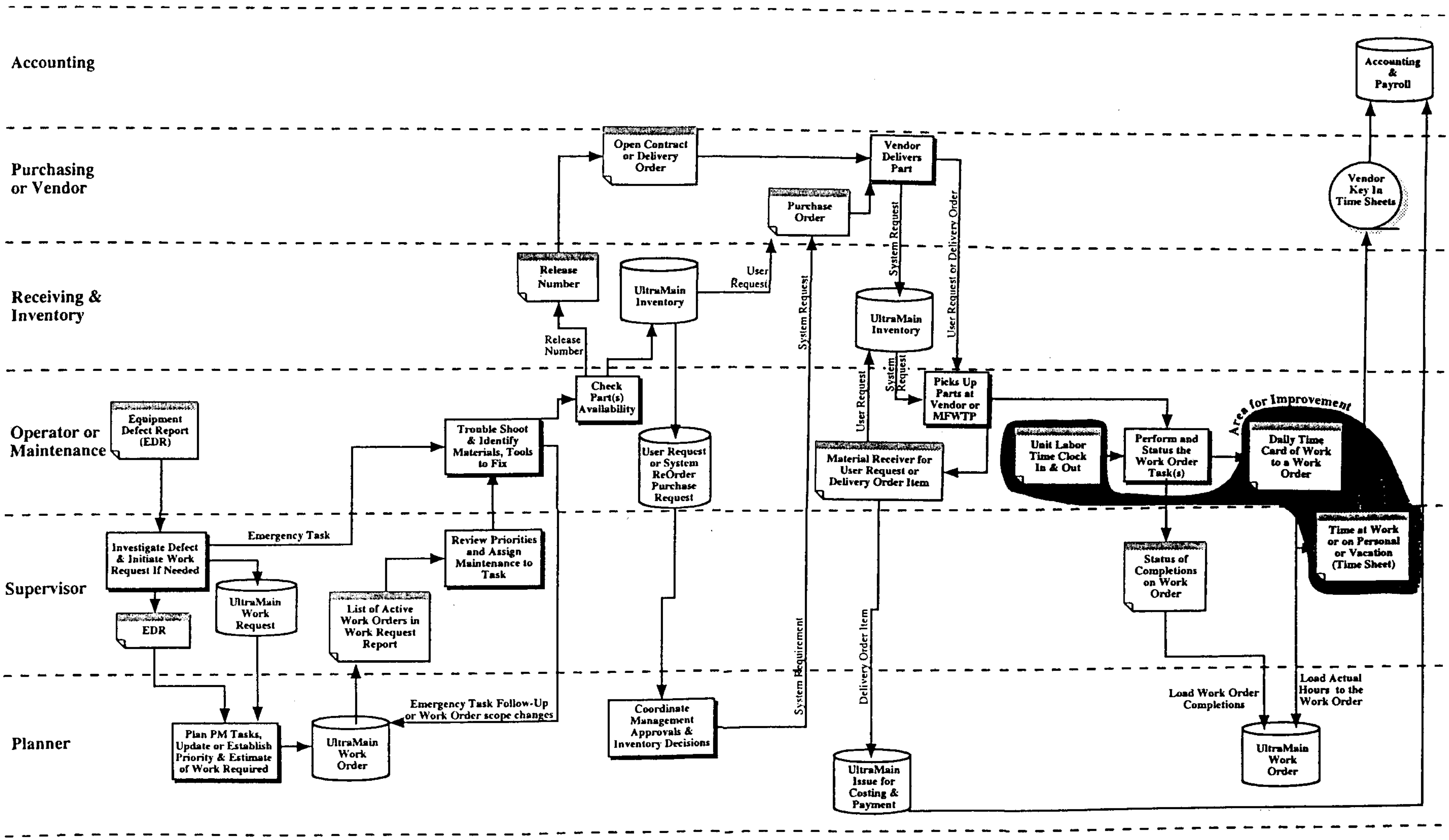
An example of a POTW process map is included as Exhibit 2-4. This map is one of more than 50 that the Louisville and Jefferson County Metropolitan Sewer District (LMSD) created as part of their current cost accounting initiative. Each of the maps takes a specific activity that is often lumped into general overhead accounts or, in this case, general capital and general operating expenditure line items, and analyzes work flow in detail. Examples of other processes mapped out include the bidding process, callbacks and agency letters, the construction change order process, and reviewing a plan of the sanitary sewer to answer a particular question.

The left side of the map illustrates the various departments within the plant utilized to complete the task in question. The steps in completing the task begin on the left and are completed on the right. This picture is one part of a complete process costing. To estimate the cost of corrective and preventive maintenance planning, for example, POTW staff would track the staff, machine, or other resources at each step to evaluate the total overhead cost generated each time an equipment defect report (see chart) is filed. Accurate costs for these general activities can be used to generate more accurate costing estimates for higher-level activities requiring these tasks.

Process mapping is also an invaluable tool in identifying how to improve operations. Perhaps the map is extremely complex, with many areas of duplication. Perhaps the costed activity is extremely expensive, suggesting that investments in improved information technology, for example, might help reduce costs. In both these situations, a careful process map can illustrate fruitful areas in which to begin improving operations. LMSD has shaded the portion of this particular process that they felt offered the most room for improvement. Process maps are also useful supports to process benchmarking (described below), where specific portions of plant operations are compared to other entities using a similar process.

Exhibit 2-4
SAMPLE PROCESS MAP

MFWTP Corrective and Preventative Maintenance Planning & Work Flowchart



Source: Louisville and Jefferson County MSD

Benchmarking

Benchmarking can be used to identify weaknesses in the POTW's products or production processes, and ways to improve on these weaknesses. Metric benchmarking compares performance quantitatively: inputs, outputs, outcomes, and the relationships among them. Basic comparisons between prices or financial ratios are commonly used metrics. Metric benchmarking can be a quick way to identify if there are problems. For example, if Manufacturer A spends more on manufacturing his product than Manufacturer B sells it for, simple price benchmarking demonstrates very clearly that Manufacturer A has a serious problem. Identifying *what* that serious problem is, a critical step in being able to solve it, requires more refined metrics and the use of process benchmarking. Process benchmarking maps ones own process against competitors that have the best performance using a similar process in order to identify where and why there are differences.[17] Exhibit 2-5 illustrates the connection between the two approaches.

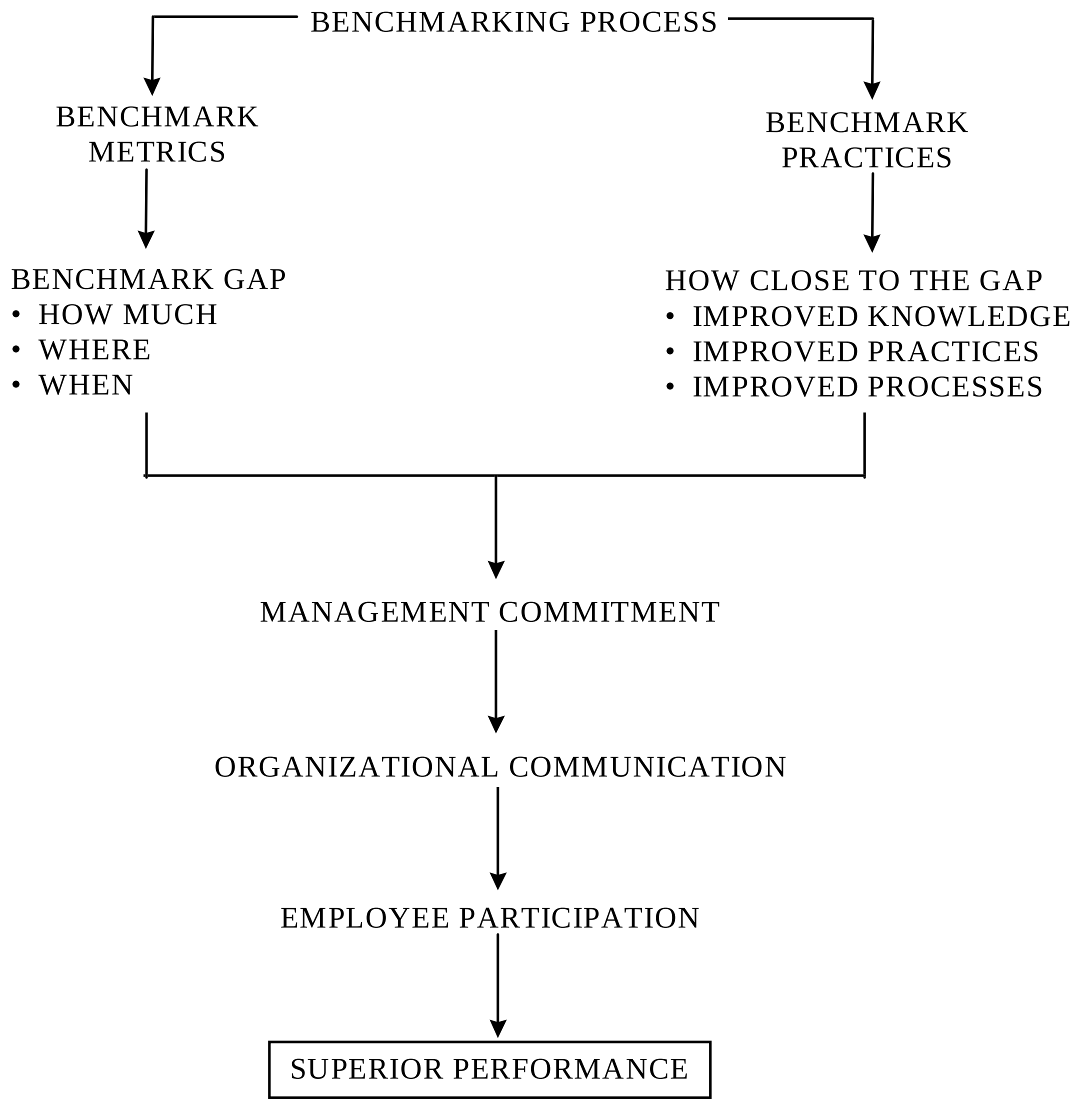
Whether using metric or process benchmarking, great care needs to be taken to be sure that you are comparing the same thing. Thus, when comparing costs, you need to be sure everybody has proper costing data. If one POTW benchmarks its costs for basic service against similar utilities and finds it is far less expensive, managers need to take their analysis to a second stage. Are there problems with how these costs are calculated (e.g., water revenues cross-subsidize wastewater treatment costs) that account for the discrepancy? Other factors may also be relevant. Is capital infrastructure older? Does your town have a better bond rating than the competitors (and thus a lower cost of financing debt)? Some of these factors may be used to adjust the comparison so that operating efficiencies can better be compared. Other factors may be used to describe why performance is worse than expected, perhaps to justify improvements or upgrades to these factors.[18]

[17] WERF (Water Environment Research Foundation), *Benchmarking Wastewater Treatment Plants Operations: Interim Report*, 1996, p. 1-5.

[18] The WERF study has attempted to normalize benchmarking for these factors by creating models for various portions of POTW operations. This approach can help identify how portions of the operation within managerial control compare across utilities. It is important not to rely solely on normalized comparisons, however, as inefficient operations whether due to "embedded" conditions such as the age of equipment or not, need to be improved over the longer term.

Exhibit 2-5

INTERRELATIONSHIP OF METRIC AND PROCESS BENCHMARKING



Source: WERF, Benchmarking Wastewater Treatment Plant Operations, 1996.

The benchmarking process is often creative in what is used as a comparable: the central goal is to identify who does the process/product of interest best, and how their approach be copied and used to improve your own operations. Comparisons can be internal (across divisions or within the same unit over time), with direct competitors (function or entire organization), with the industry functional leader (specific function against leaders in that function, even if not a direct competitor), and finally based on a generic process (against process leader, even from a different industry).[19]

[19] WERF, p. 2-6.

Process mapping often pulls best practices for particular operations from a wide range of other industries, some fairly far afield from their direct line of business. For example, a comparison of billing operations might compare POTW billing to that used by major telephone companies or package delivery services. Peak leveling efforts or management information systems would likely use a cutting-edge electric utility, where demand-side management efforts and geographic information systems have been established for longer than in the POTW arena. For other areas, such as pretreatment, benchmarking efforts would likely focus on cutting-edge POTWs, such as recent EPA pretreatment award winners. Benchmarking is normally done as a continuous process in order to ensure that the POTW operations also continuously improve.[20]

Most POTWs undertake some form of benchmarking. For example, tracking trends in metals loadings over time is almost universally done. A study now underway by the Water Environment Research Foundation explores the many additional uses of benchmarking within POTWs and is an extremely good reference for utilities who plan to undertake an extensive benchmarking exercise. Exhibits 2-6a - 2-6c below, developed by WERF, illustrate a variety of metrics managers can use to track their performance. These metrics include outcome measures, efficiency measures, and effectiveness measures. Outcome measures focus for the most part on how external agents evaluate POTW performance, such as through complaints or bond ratings. Efficiency performance measures are cost ratios per unit of service provided, and help identify higher cost parts of the POTW's operations. Finally, effectiveness performance measures include measures of labor input per unit output, or the technical effectiveness of existing plant and equipment. The sheer number of metrics identified by WERF focus groups illustrates the importance of choosing the most important metrics for a particular utility.

[20] WERF, p. 2-4.

Exhibit 2-6a:

KEY OUTCOME PERFORMANCE MEASURES IDENTIFIED BY FOCUS GROUP

Functional Area	Outcome Measures
Automation	Degree of Automation Effectiveness of automation
Collection Systems	Number of collection system complaints Number of claims per year Number of overflows per year Moratorium due to collection system Time to repair collapse (in hours) Percent of system inspected per year
Customer Service	Time per call Abandonment rate Average agent availability Average time to clear: - complaint - service call, etc. New account cycle time Walk-in average time to serve Plan review/turnaround time Time to billing adjustment Customer satisfaction (survey/focus group, etc.)
Biosolids Management	Number of odor complaints Number of citizen complaints (related to dry process) Quality of biosolids (Class A or B) Dry tons produced/strength factor Permit violations Redundancy in land applications Forecasted life of biosolids arrangements
Finance, Administration, & Planning	Residential flow per capita at plant (over time) Audit exceptions and comments Bond rating Operating reserves On time payments
Labor and Staffing	Injury days lost per full time employee Number of grievances processed
Wet Operations	Number of exceedences Number of complaints Number of odor complaints Total hours lost to injury

Source: WERF, Benchmarking Wastewater Treatment Plant Operations, 1996

Exhibit 2-6b: KEY EFFICIENCY PERFORMANCE MEASURES IDENTIFIED BY FOCUS GROUP	
Functional Area	**Efficiency Measures**
Automation	Cost of automation projects (one time/annual)
Collection Systems	Maintenance cost per mile Maintenance cost per Mgal/day Maintenance cost per kWh installed
Customer Service	Training expenditure ($) per agent Customer service costs per day Customer service costs per customer Customer service costs per total overhead and maintenance (O&M) cost
Biosolids Management	Dollars per dry ton Dollars per ton mile Chemical costs per dry ton Power costs per dry ton Maintenance costs per process Fuel cost per dry ton (incineration) Revenues from product sales Gas utilization credit (dollars)
Finance, Administration, & Planning	Overhead costs per total O&M costs Labor cost per total O&M costs Contract services O&M costs per total O&M costs Debt service per total budget Annual materials cost per inventory Training cost per capita Fleet costs per total O&M (by function) Return on assets Value of main replaced per total value of main Value of capital additions/net asset value Replacement value of plant (annual)
Labor and Staffing	Overtime cost per total labor costs Training costs per employee Total benefits costs per total labor (by type)
Wet Operations	Cost per Mgal Cost per lab analysis Cost per customer account Maintenance costs per Mgal Overtime costs

Source: WERF, Benchmarking Wastewater Treatment Plant Operations, 1996

Exhibit 2-6c

KEY EFFECTIVENESS PERFORMANCE MEASURES IDENTIFIED BY FOCUS GROUP

Functional Area	Effectiveness Measure
Automation	Instrument per Mgal/day Instrument engineers per Mgal/day Number of operats per shift Number of shifts per week Number of operations automated Number of administration operations automated Number of information operations automated Number of processes that run automatically per total number of processes
Collection systems	Full-time employees per mile Full-time employees per MG Level of infiltration/inflow (I/T) Number of blockages per year per mile Number of collapses per year per mile Percentage of work orders completed in __ days
Customer Service	Complaint calls per 1,000 customers Percentage of calls that are repeats Percentage of problems cleared in __ days Percentage of billings collected in __ days
Biosolids Management	Full-time employees cost per dry ton (each unit process) Operations cost Maintenance cost Percent volatile suspended solids (VSS) reduction (digestion) Cubic feet gas per pound VSS (anaerobic digestion) Percent moisture reduction (after dewatering) Tons product sold per total tons solids Percent planned per total maintenance Equipment availability (breakout by process)

Source: WERF, Benchmarking Wastewater Treatment Plant Operations, 1996

Exhibit 2-6c

KEY EFFECTIVENESS PERFORMANCE MEASURES IDENTIFIED BY FOCUS GROUP (continued)

Functional Area	Effectiveness Measure
Finance, Administration, & Planning	Budget to actual : - Total expenses - Capital improvement program (CIP) expenditures Major project costs per encumbered amounts Forecasted per actual demand Debt to equity ratio Quick ratio Coverage (debt service ratio) Billable flow per actual flows at plant Revenue distribution (fixed charge/variable) Percent reuse as reclaim (growth over time) Projected demand per projected capacity at end of planning horizon Ratio influent/capacity
Labor and Staffing	Definable work rates (over time) Number of operators per shift Full time employees per Mgal/day (Permanent, part-time, contract) Number of labor classifications
Wet Operations	Percent removal Full-time employees per Mgal Full-time employees per customer account kWh/Mgal Number of analyses per technician Cubic feet of air treated per Mgal Connected HP/gal

Source: WERF, Benchmarking Wastewater Treatment Plant Operations, 1996

3. TOPICAL DISCUSSIONS OF COMMON PROBLEM AREAS

This Chapter discusses a number of areas of common concern for POTWs, though it is not intended to be an exhaustive listing. In addition, not every issue will apply to every plant. Nonetheless, we hope that these examples provide useful illustrations of the value of cost accounting and budgeting tools in achieving tangible gains in program performance.

The underlying theme for both budgeting and cost accounting modifications is getting the price signals right. Cost accounting essentially creates price signals *within* the organization that help managers rationalize their use of scarce resources. Budgeting organizes this information to set constraints on the resources available to these managers and groundrules on how the resources can be used. Often, this internal pricing information supports changes to external prices (through rate changes), sending the proper price signals to customers of the POTW.

Given the importance of this signaling in modifying behavior to conserve resources and better protect the environment, it is important to briefly mention a couple of general steps the POTW can take to improve the impact of price signals:

- **Timing and Frequency of Measurement.** Many discharge fees are based on periodic measurements of influent and effluent. The Clean Water Act sets statutory minimums for the type and frequency of testing. However, these minimums are unlikely to be frequent enough to (1) rapidly track changes in effluent characteristics; and (2) create certainty that all of these changes will lead to adjustments in the surcharge levels. Thus, more frequent measurement can be expected to provide better signaling to dischargers about what part of their operations is most important to address quickly.[1]

- **Frequency of Billing.** As with the frequency of measurement, if customers receive large bills infrequently (e.g., quarterly or annually), they are unable to react quickly to changes in rates and unable to associate specific behavior with increases in their discharge levels. This situation also applies in communities that commingle wastewater charges with their overall property taxes. All of these circumstances tend to reduce discharger responsiveness to price signals.

<u>Cross-Subsidies In General</u>

As noted above, poor cost accounting matters because it sends both managers and customers the wrong signals about the financial impact of decisions. These signals can lead the

[1] One POTW with large industrial user flows allocated much of the plant's fixed capital based on the strength of contributed wastewater. Since the financial implications of this measurement were so substantial, the IUs tested their wastewater strength on a daily basis.

POTW to invest in the wrong parts of its treatment system and for dischargers to underinvest in pretreatment or conservation. Normally, POTW rates are set to recover the cost of providing WWT services. Thus, in the aggregate, revenues may equal expenditures. However, quite often certain customers, types of customers, or geographic regions are paying too little, while others are making up the difference by paying too much. The existing discharge fees therefore include *cross-subsidies.* Exhibit 3-1 below presents a range of possible cross-subsidies within POTWs that we visited. Important issues to consider when evaluating cross-subsidies include:

- **Magnitude.** If the price signals aren't perfect, but are fairly close, the cost and disruption associated with eliminating them may not be worth the gains. Magnitude should be evaluated in an absolute sense, however. For example, if every residential and commercial customer is paying only 2 percent more each month to subsidize the oversight of industrial dischargers, this may not seem significant. However, since there are so many customers, this 2 percent could constitute a 50 or 100 percent subsidy to particular IUs, which would likely have a substantial impact on the level of pretreatment investment.

- **Distortions.** How important are the distortions created by the existing cross-subsidies in impeding strategic goals of the POTW? For example, if water is scarce in your region but you can't reuse your effluent for irrigation due to discharges of one or two constituents by a handful of industries, the resulting distortions are likely large both financially and environmentally. In contrast, if rates to one IU are slightly higher than they otherwise would be, but wastewater fees are an insignificant cost of business for that discharger, large investments by the POTW to correct the problem are clearly unwarranted.

- **Impact.** Correcting cross-subsidies will change the cost of wastewater treatment to dischargers, encouraging them to modify behaviors that cause the POTW to incur the highest costs. The impact of these changes can reduce or delay the need to expand expensive capital infrastructure. However, for POTWs that have *already* built capacity large enough to handle discharges under the distorted pricing, eliminating cross-subsidies will not be quite as efficacious. The capital costs must still be paid whether or not the capital is being used by dischargers. Thus, cross-subsidies are most important to eliminate when capacity is constrained.

- **System Boundaries.** The boundaries of analysis can affect which cross-subsidies appear the largest and most in need of correction. For example, a cost accounting analysis of POTW dischargers may illustrate that IUs are

Exhibit 3-1

POSSIBLE CROSS-SUBSIDIES IN POTW PRICING AND RESULTING DISTORTIONS

Cross-Subsidies	Explanation	Resulting Distortion(s)
Among Industrial Users	Costs of pre-treatment may be allocated equally across IUs, rather than based on which specific firms create costs for the POTW.	-Industries discharging effluent that is most costly for the POTW to handle will pay less than they should and underinvest in pretreatment. -Relatively clean IUs will pay more, serving as a barrier to new industries locating in the region.
Among different parts of the POTW service area	Fees for service may be equalized for all dischargers (industrial, commercial, and residential) within the Sewerage District, despite large differences in the cost of providing this service. Examples include multi-plant systems where one treatment plant is at capacity and others are not; or collection areas with particularly high pumping costs.	-New dischargers will not receive price signals to locate in the less expensive portion of the service area. -POTW managers will not see which parts of their systems are most costly to run and factor that into future expansion decisions. For example, peripheral areas may be better served through decentralized modular WWT rather than collection system expansion.
Among IUs and other wastewater treatment (WWT) customers	Charges on industrial users may be too low to cover (a) the costs of permitting and overseeing them; and (b) the cost impacts they have on the system.	-Industries don't receive the proper price signals about how their discharges affect the treatment system and will underinvest in conservation and pretreatment.
Between different municipalities	-Agreements with surrounding municipalities may not allow POTW to set fees at levels that adequately cover the cost impacts of the imported discharge. -Customers in the periphery of a service area may be charged more because they are in a different political jurisdiction. This surcharge may have nothing to do with the cost of service.	-Dischargers in the surrounding area will underinvest in conservation and/or pretreatment. -Dischargers in the periphery may be hesitant to hook into the central system even if it is economically efficient. Dischargers in the center may receive artificially low rates and underinvest in conservation and/or pretreatment.
Between water consumers and waste water treatment customers	Integrated water and wastewater utilities sometimes subsidize new WWT expansion or construction with surplus revenues from water sales.	-Dischargers may underinvest in conservation and/or pretreatment. -POTW may be under less pressure to improve the efficiency of their operations.
Between the general taxpayer and the industrial users; between the general taxpayer and WWT	The POTW may receive general taxpayer support (e.g., state or federal grants, general taxpayer funds) to finance WWT or pretreatment. Construction grants or subsidized revolving fund loans for plants with a high ratio of IU flow to total flow essentially subsidize industrial WWT.	-Dischargers may underinvest in conservation and/or pretreatment. -Polluting industries, through reduced WWT costs, improve their relative competitive position vis-a-vis industries that pollute less.
Between agricultural consumers of fresh water and WWT	In water scarce regions, federal policies often subsidize the extraction and delivery of fresh water to agriculture. As a result, treated effluent from POTWs becomes less competitive.	-Effluent management is more expensive. -Market incentive for farms to seek out and exploit treated effluent is weakened or destroyed. -Efficiency of water utilization in the region declines.

moderately subsidized through higher charges on residential and commercial dischargers. However, if a watershed perspective were used, it may become evident that the largest cross-subsidies are actually going to industrial *direct* dischargers. Managers should keep this boundary issue in mind as they consider where to focus their resources.

Below we have classified the types of situations where distortions in costing are particularly likely. Included are differences in the cost of treating discharges or dischargers, difficulties associated with peak discharges and system expansions, and problems from rigidities inherent in political agreements between municipalities such as interjurisdictional agreements.

Specific Types of Discharges May Force POTW to Incur Higher Costs

Where specific types of discharges contaminate either the plant's collection system or its residuals, treatment costs can rise substantially. The incremental management costs should be tracked and allocated back to the source that is driving the cost increases. Biosolids management, effluent reuse, and oil and grease discharges provide three useful illustrations of this point.

Biosolids Management

Solid residuals (biosolids) from wastewater treatment can be managed in a number of different ways ranging from beneficial reuse as soil amendments to incineration and landfilling of ash. The cost implications of these practices differ widely. Since biosolids management comprises between 25 and 30% of WWT operating costs,[2] contaminants that force higher-cost management of the material can have large dollar impacts on the cost of running a POTW.

EPA sludge regulations stipulate the maximum allowable concentration of numerous contaminants (metals, pathogens) in biosolids that are land applied. Restrictions on contamination levels are even more stringent to meet EPA's highest grade ranking, and may be higher still to meet the demands of particular customers willing to accept the residuals. As soon as contamination levels in any one area exceed the allowable threshold, the POTW must dispose of the biosolids as a lower grade product, or, in some cases, pay to incinerate it or dispose of it in a permitted landfill.

Consider the example at Massachusetts' Water Resources Authority (MWRA). The facility invested in a sophisticated sludge pelletization facility that normally produces a product sold as fertilizer. Yet, during the summer months molybdenum (Mo) from air conditioning cooling towers drives Mo concentrations high enough that the pellets cannot be distributed in the state, preventing the POTW from utilizing its biosolids in an optimal manner. POTW management can rectify this constraint by increasing the amount of biosolids over which the same amount of Mo is distributed (not a real option) or by reducing the amount of Mo that remains in the residuals through source reduction.

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[2] "Biosolids: A Business by Any Other Name Would Smell as Sweet," *Environmental Business Journal*, February/March 1996, p. 9.

Exhibit 3-2 BIOSOLIDS MANAGEMENT	
Common Practice	**Improved Cost Accounting/Budgeting**
<u>Cost Accounting</u> -Costs of biosolids management recovered through general user fees on all dischargers. -Where biosolids quality is poor, more expensive management options are pursued. Cost of these are spread among all dischargers. Voluntary reduction plans or new local limits are implemented to bring contaminant levels down.	-Cost for highest quality sludge allocated to all dischargers based on quantities discharged. -Incremental costs associated with poor sludge quality allocated to dischargers of constituent(s) for which the biosolids don't meet the highest standards. -If POTW unable to allocate full charges to these dischargers, they can evaluate outreach or financing pretreatment upgrades that reduce overall WWTP costs.
<u>Budgeting</u> -Biosolids management costs are listed as a line item. -Residuals testing costs may be listed under general laboratory costs.	-All related biosolids costs would be grouped together.

Proper cost accounting should allocate the *entire* extra cost of biosolids management to the activity that created that cost: Mo dischargers. Mo emissions are but one example; other POTWs may have exceedances in a variety of metals. These emissions can often be linked to specific industrial users, or to IUs as a group. For example, one plant on the East Coast receives a very high proportion of its flow from industries. The level of contaminants in this flow is such that they need to incinerate biosolids prior to disposal to destroy any remaining organics. The full extra cost of the treatment is properly borne by the IUs rather than spread among all customers.[3]

What POTW managers choose to do with this information is up to them; the cost accounting system merely tells them how much a particular occurrence costs them. Traditionally, exceedences were met with regulatory reductions in allowable discharge levels. Many alternative options are available:

- The POTW could increase discharge fees for the constituents of concern, encouraging dischargers to implement better controls. This could be done through direct fees, or through some type of effluent trading system.

- If the costs to the system from particular discharges are extremely high, but delays associated with modifying permits or increasing discharge fees too long, the POTW might actually find it economic to pay to install treatment equipment on the sites of large dischargers. This approach is analogous to demand-side management programs used for years by electric utilities.

[3] This statement assumes that land application is less expensive than incineration. For POTWs that already have incineration equipment, the *variable* costs of burning biosolids could well be less than the *total* costs of land application -- at least until the burner needs to be replaced.

- If the costs of controlling the discharge are extremely large in comparison to the cost of incinerating rather than land applying biosolids, the POTW may decide that its current practice makes the most sense economically (though not necessarily environmentally).

Effluent Reuse

The issues related to effluent reuse are quite similar to those associated with biosolids. A well-functioning POTW will generally produce an effluent that is of sufficient quality that it can be reused for some beneficial purposes. However, contaminants in effluent such as metals, salt, or microbes, may prevent reuse of effluent for irrigation. Where are these contaminants coming from? A detailed study of sources of salinity in Escondido, CA found that water softening plants were among the largest sources of salinity in the discharge area. The salts introduced by these plants were increasing the salinity of effluent to the point that the water was unattractive to farmers.

Exhibit 3-3

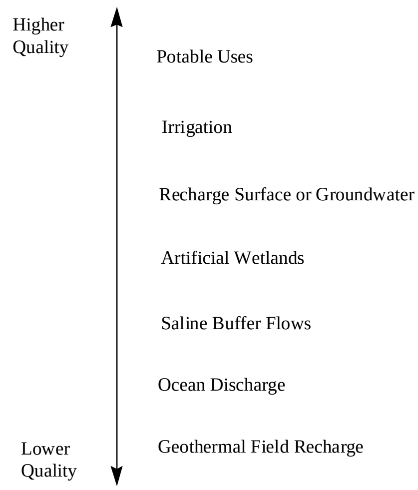
EFFLUENT REUSE

Common Practice	**Improved Cost Accounting/Budgeting**
Cost Accounting -Effluent is often discharged in compliance with NPDES permit and forgotten about. -Foregone opportunities to resell the effluent not evaluated.	-In water scarce regions, the cost of managing clean effluent is allocated among all customers based on volume of discharge. -Lost cost savings from reselling the treated water to farmers or other bulk users is allocated directly to the dischargers responsible for discharging the constituents that make the water unattractive to these alternative outlets. -If interest in reusing the treated effluent is low, POTW needs to evaluate whether existing subsidies to clean water (e.g., due to federal water projects) is artificially depressing the value of reclaimed water for non-potable uses.
Budgeting -Effluent testing (e.g., Whole Effluent Toxicity) is often grouped under the laboratory costs. -Revenues from effluent resale go into general fund.	-All costs associated with monitoring and marketing effluent should be grouped under an effluent management category. -Revenues from effluent sales should be credited to effluent management.

Escondido is a useful illustration because the plant is located in a water-scarce region of the country (near San Diego, CA), where demand for fresh water is extremely high. Logic suggests that there would be many users interested in the region's effluent, especially for non-potable but higher value uses such as irrigation (see Exhibit 3-4). Yet this is not the case. The quality of Escondido's effluent is not yet high enough for agricultural usage, due to the discharge of constituents such as total salts, chloride, boron, nitrogen, bicarbonate, manganese, and fluoride.[4] Boron and chloride are of particular concern to avocado growers, a large potential irrigation customer.[5] These discharges are predominantly from industrial and municipal dischargers; the rates charged to these dischargers do not reflect the lost opportunity to resell the water.

Exhibit 3-4

EFFLUENT REUSE OPTIONS



Despite these contaminants, side agreements between farmers and dischargers would likely work to reduce the loadings of these constituents if the reclaimed water were sufficiently valuable. Despite widespread shortages, Escondido's effluent is not sufficiently valuable to farmers to induce these types of arrangements. This is an arena where price distortions within the POTW combine with price distortions outside to encourage wasteful use of natural resources.

Reclaimed water is most applicable for re-use in irrigation. Yet, it must compete with irrigation flows from other sources. In most of the southwestern United States, this water comes through heavily subsidized federal irrigation projects. Many of the federal water projects do not charge irrigation users the interest on the debts incurred to construct the facilities. Many do not even recover the full costs before interest.[6] Historically, irrigators have repaid only about 47

[4] HYA Consulting Engineers, *City of Escondido Brine Management Feasibility Study*, August 1995. Prepared for the San Diego County Water Authority, pp.3-5.

[5] Ibid., p. 3-5.

[6] U.S. General Accounting Office, *Water Transfers: More Efficient Water Use Possible, If Problems are Addressed*, May 1994, p. 23.

percent of the total costs allocated to them.[7] This percentage would be much lower if interest were compounded on the capital costs of water projects (which the farmers do not have to pay), as is normally done with capital investments.

Thus, farmers have received water rights well below the cost of delivering that water. If the farmers could then turn around and sell their water rights to other users, they would receive a windfall, but water would be priced efficiently. However, historically, farmers have not been able to sell their water rights in federal projects to other users, and thus faced a cost of using it on their crops far below what others were willing to pay for those rights. With artificially cheap fresh water to use on their farms, farmers have little incentive to invest in creative strategies to reuse treated sewage. With artificially low discharge fees, the dischargers of the constituents of concern face little incentive to reduce their discharges.

Fats, Oil And Grease (FOG) Discharges And System Maintenance Costs

FOG discharges affect the collection system by clogging up pipes and pumping stations. Sources include restaurants, auto shops, and food processing plants. As with biosolids and effluent quality, discharges from a subset of system users can create large costs for the POTW. Unless these costs are measured, utility staff may not invest the adequate resources to deal with the problem. For example, one POTW in the Washington, DC area had numerous restaurants as IUs. Despite efforts by the pretreatment program to control FOG discharges, main pumping stations required expensive degreasing on a regular basis.

No tracking of how much materials, labor, and downtime associated with these clogs cost the POTW per year was done. In fact, the pretreatment coordinator expressed frustration that the maintenance staff assumed the work was costless, since they were salaried employees. This inability to recognize the *opportunity cost* of time is often at the root of poor allocation decisions within a POTW. While the maintenance staff were salaried, and thus did have to be at work anyway, they could have been usefully employed on other tasks.

Once the cost is recognized, POTW staff can determine the most effective follow-up strategy. In many cases, allocating the full cost of dealing with a problem such as oil and grease clogs back to the contributory restaurant provides an extremely effective deterrent to improper management. In the case of this particular POTW, however, political pressures made it difficult to pass any substantial charges back onto restaurants due to a strong local restaurant lobby. However, properly accounting for the costs might have shown POTW managers that more outreach and education in this area was likely to pay off.

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[7] U.S. General Accounting Office, *Bureau of Reclamation: Information on Allocation and Repayment of Costs of Constructing Water Projects*, July 1996.

For example, the POTW could have educated the restaurants about the growth in biodiesel, a blend of diesel and bio-derived diesel originating, in part from waste cooking oil.[8] Biodiesel blends, in conjunction with a catalytic converter, can reduce emissions of existing diesel vehicles so they meet CAA standards and reduce air pollution in non-attainment zones.[9] This growing outlet for FOG creates a lower cost disposal option than previously existed, potentially reducing illegal discharges.

Exhibit 3-5

MANAGEMENT OF FATS, OIL, AND GREASE

Common Practice	**Improved Cost Accounting/Budgeting**
<u>*Cost Accounting*</u> -FOG dischargers are forbidden from discharging these constituents to the collection system. -They pay a permit fee which may or may not reflect the full cost to permit and oversee them. -They may or may not be charged substantial penalties for failure to empty their grease traps or when they clog a collection pipe. When costs are charged back, they often exclude indirect costs such as staff time, travel costs, etc.	-Permit fees should cover the full cost of permitting FOG dischargers and the full costs of any uncovered FOG-related cleaning of the collection system. -Full costs of addressing clogs should be charged back to the firm causing the problem. -If unrecoverable FOG costs are large, POTW should increase outreach to explain new options for FOG management.
<u>*Budgeting*</u> -Cost associated with oil and grease are often lumped under the general collection system line item. Permitting for oil and grease is often in the pretreatment line item.	-A line item for the entire FOG management program should be included in the budget, and contain all costs related to permitting, outreach, and FOG-related maintenance. -Any costs related to system downtime during a grease clog should also be charged to the FOG program.

<u>Specific Types of Customers May Cost More to Service than Others</u>

Not all customers are created equal. POTWs need to recognize differences in the demands that these different types of customers put on their staff and on their system. This is generally done to some degree by all POTWs. For example, monthly service fees are higher for larger sewer mains, and surcharges are usually levied on high strength wastewater. However, there are many other ways that the costs associated with particular customers are not reflected in rates. When POTWs do not recognize all of the important differences across customer classes, their fee structures will contain a variety of behavior-distorting cross-subsidies. It is common that

[8] Waste oil fractions of bio-derived fraction are currently about 50 percent, with the other half from virgin soybeans.

[9] U.S. Department of Energy, *Biofuels Update*, Winter 1997, p. 3; Fall 1996, p.1.

residential users end up subsidizing industrial dischargers.[10] Since it is the industries that generally discharge most of the difficult or impossible to treat contaminants (e.g., metals), cross-subsidies often end up subsidizing polluters, violating the polluter pays principle.

Permitting Costs

At least every five years, each industrial discharger must receive a new discharge permit. The cost to provide this permit can vary widely. Small, standardized industries, such as one-hour photo shops, have the same processes and the same issues in every shop. In addition, the emissions from any single facility are unlikely to be large enough to cause operational or compliance problems for the treatment plant. Permits can be standardized, and site visits are not always needed. MWRA, for example, has adopted a group permit for all small photo shops and printers, that applies automatically. This "group permit" approach saves substantial staff time.

Exhibit 3-6

PERMITTING COSTS

Common Practice	**Improved Cost Accounting/Budgeting**
Cost Accounting -Permit fees cover a portion of total permitting costs. -Where fees do cover the full cost of the program, the fees for any specific permittee may be substantially different from the time required to permit them.	-Residential and commercial customers should not cross-subsidize IUs. -IU permit fees should be grouped by class of facility, should include administrative support costs (such as computer systems). -Labor costs, including those to write the permit and those required for inspecting the plant, should be charged directly to the customer. Thus, complex firms would pay higher permit fees.
Budgeting -Permitting costs are often lumped into the general pretreatment budget, if pretreatment has its own budget section at all. -Permitting, regular inspections, and enforcement inspections are sometimes lumped together, or simply included in the overall labor line item.	-Permitting, regular inspections, and enforcement inspections should all be separate line items in the pretreatment budget.

In contrast, consider a large automotive manufacturer. This manufacturer will have multiple processes, and sometimes multiple discharge points. The impact of this plant's discharges on the POTW system can be substantial, but there are no other similar plants in the service area. It is obvious that developing a permit for this type of company will require far more time for staff, inspectors, and administrators than the small, simple plant. A cost accounting system that properly measures how staff time is used and the costs associated with various steps

[10] In terms of *total* charges, residential users often subsidize industrial users. In some cases, as noted below, the *fixed* service charges on residential customers are subsidized as well.

of the permitting process, can give POTW managers a much better feel for the incremental cost of this type of discharger. This information can then be used to justify charging such a firm for these permitting costs, reducing the burden on residential customers and small businesses.

Serving Industrial, Commercial, and Residential Customers

Providing metering and billing services, and operating and maintaining lateral collection lines, are fairly fixed costs. For larger customers, meters might be a bit more expensive, and the collection lines might be larger. However, many of these basic service costs are the same whether one discharges five gallons of water per month or fifty thousand. In their basic rates, many POTWs have tried to recognize this fact by charging fixed monthly service fees. A more sophisticated cost accounting system will allow the utility to understand these differential rates more clearly, perhaps refining their charges. Cross-subsidies with basic service tend to undercharge small residential customers. This practice is dictated by a desire to make at least basic wastewater treatment service available to all homes. By targeting universal service based on consumption rather than income, this approach also unnecessarily subsidizes small residential customers who have more than adequate income to pay the full charge.

Residential customers, however, require very little in the form of additional services from POTW staff than hookups, metering, and billing. In contrast, industrial customers require an entire pretreatment program. Aside from permitting costs already mentioned, a pretreatment program expends substantial resources to inspect, enforce against, and educate industrial users. In providing these functions, the POTW incurs substantial support costs related to litigation, information management, and laboratory testing. Many plants track only very basic pretreatment costs such as direct pretreatment staff. The substantial costs associated with the infrastructure that is used to support the pretreatment program (e.g., staff training, legal, space rental, even sometimes laboratory fees) are often lumped in the general overhead of the POTW rather than allocated back to specific industrial dischargers.

The result can be a complicated mix of cross-subsidies among customer classes. In some cases, the costs of running the pretreatment program exceed collections from industries from permitting fees, other fees, and surcharges on discharge. In other cases, while industrial users overall do cover the costs of pretreatment in total, payments by specific industries bear little relationship to the costs they place on the POTW infrastructure. Subsidies tend to flow to large, complex industries (who are charged the same flat rate as smaller firms) and to small categorical industries (who require substantial regulatory oversight but are too small to afford a large user fee).

<u>Insights on Regulatory Efficiency</u>

Cost accounting systems can help the POTW evaluate the efficiency of regulatory requirements and the efficiency of its own implementation of pretreatment requirements. Consider the following two examples:

- **Small Categorical Industries.** Small categorical industries provide an instructive example for evaluating environmental cost/benefit tradeoffs. EPA currently requires that all categorical industries be permitted and monitored, simply because of the industrial processes they use. In some cases, however, the firms are so small relative to the POTW's flow that their operations are irrelevant to wastewater quality in the region. Yet the staff time required to permit and inspect these firms can be substantial. In this situation, allocating these costs directly to the small firm may be unworkable, as the charges would be excessive. However, tracking the costs can help the POTW illustrate the relatively poor cost/benefit trade-off associated with the current regulatory regime for small CIUs, and provide useful input to EPA's current streamlining effort that may change some of these requirements.

- **Cost of Pretreatment Program.** A well respected POTW on the west coast wanted to better allocate the cost of its pretreatment program to the industrial dischargers. It undertook a fairly extensive effort to assess the differential workload to implement its pretreatment program for different classes of customers (e.g., large industrial dischargers, small industrial dischargers). Included was time spent on permitting, sampling, inspections, report reviews, enforcement activities, laboratory analysis, and administration. The resulting numbers showed increases in allocated fees for most industries of between 27 and over 10,000 percent. The upper end of this range was for categorical industries with extremely low flow. However, even relatively large firms would have received substantial rate increases. Faced with these figures, the POTW decided to retain a substantial portion of the cross-subsidy between residential/commercial customers and IUs, increasing IU charges only slightly. Managers did not seem to consider the extremely high fixed costs of the program per discharger as an indication that (1) some of the regulatory requirements were inefficient; or (2) that their implementation of the requirements could be streamlined. Retaining the cross-subsidy removed the financial pressure to address these other factors.

Improving Charge Backs for Cost of Service

Even if industrial users do pay the entire cost of the pretreatment program, there may be distortions *within* this group of users. This occurs because the oversight requirements can vary widely across different industries due to the size, type, or complexity of a particular plant. Improving the tracking and charge backs for these types of services can greatly reduce cross-subsidies. Below, we present a number of activities that could benefit from this approach.

Sampling and Laboratory Support

Federal law requires sampling IU discharges a minimum number of times per year. These samples must then be analyzed. Many POTWs add up their laboratory fees, divide by the number of IUs, and recover these costs in fees. This approach is relatively simple, but does not accurately reflect the costs to the POTW associated with sampling and testing. First of all, not all procedures are the same complexity (or cost). For example, testing for pH is straightforward and inexpensive; certain metals analyses are not. Tracking costs more carefully provides important information to the POTW:

- Are there certain analytical tests that we do too few of to justify the capital equipment needed to do them and should be outsourced? This decision must be viewed not only in terms of dollar savings, but in terms of how the speed and quality of results on outsourced testing compares to doing it in-house and affects the POTW's basic mission. Many POTWs have reduced costs substantially by sending some specialized analyses to outside labs, or by increasing their analytical volume by accepting samples from other municipal agencies (in-sourcing).

- Are there certain IUs that create a substantial cost burden on us because of the types of materials they discharge? Are there ways to help them substitute less-problematic materials or switch to zero discharge?

Exhibit 3-7

SAMPLING AND LABORATORY FEES

Common Practice	**Improved Cost Accounting/Budgeting**
Cost Accounting -Lab and sampling fees absorbed by utility; or -Lab and sampling fees divided evenly among IUs.	-Costs of actual sampling and analytics required tracked and charged back to specific IUs. -Costs include labor of sampling or lab technician. -Costs include overhead related to equipment used: depreciation, rent on laboratory space, etc.
Budgeting -Laboratory budget listed as a separate line item. - Sampling costs hidden in overall pretreatment budget.	-Laboratory costs related to pretreatment shown as a line item in the pretreatment budget; laboratory costs associated with other activities grouped with those activities. -Sampling costs listed as a separate line item under pretreatment and enforcement, depending on reason for taking samples.

Because IUs often send their own samples to private labs for analysis, they will be familiar with the prevailing charges for particular types of analytical work. This makes benchmarking laboratory performance both easy to do and quite important. If full costing of laboratory tests inside the POTW suggests the tests are substantially more expensive than external ones, POTW managers will need to proceed cautiously in terms of what they charge IUs. They should also identify the reason(s) that internal services are more expensive and use this information to guide their next steps.

Enforcement Activities

As soon as a violation is suspected, pretreatment activity for a specific IU tends to increase. Inspection visits are likely to rise, including some surreptitious sampling. The number of samples being taken and analyzed will also rise. If litigation begins, legal costs for the POTW will also increase substantially. The polluter pays principle suggests that all of these costs should be passed on to the violator. Where a violation is suspected, but not found, enforcement costs should be borne by the pretreatment program overall, but not charged to the specific facility.

Exhibit 3-8

ENFORCEMENT ACTIVITIES

Common Practice	Improved Cost Accounting/Budgeting
Cost Accounting -Increased inspection costs absorbed in general pretreatment program costs. -Increased laboratory analysis often included in general laboratory spending rather than charged to the IU.	-A cost object should be set up for each IU under enforcement suspicion, with all related work (inspection, sampling, litigation) tracked and recovered from the IU. -If a suspected violation turns out not to be real, costs should be borne by all IUs in general.
Budgeting -Costs for inspection, laboratory analysis, and litigation are generally spread into three functional areas (pretreatment, laboratory, and legal). This makes it difficult to track spending per case, an important figure when setting penalties.	-Managers should have the ability to track spending by case. An enforcement line item that contains all supporting sub-activities might be a way to accomplish this.

Costing Wastewater Treatment Separately from Water Delivery

Across the country, many districts are served by integrated utilities that provide both water and wastewater services. Integration of the services can offer efficiencies, such as coordinated billing. However, many integrated utilities do not make a clear distinction between the costs of the water and those of the wastewater system. As a result, the fees set by the utility may send the wrong signals to customers. If water is underpriced, customers may not adequately conserve water. If wastewater is underpriced, large dischargers will have a reduced incentive to improve their in-plant reuse of water.

Exhibit 3-9 WASTEWATER TREATMENT AND WATER TREATMENT/DELIVERY	
Common Practice	**Improved Cost Accounting/Budgeting**
<u>Cost Accounting</u> **-**Functional services provided to both water and wastewater customers are not tracked separately. Examples include administration, laboratory, and information systems.	**-**Activity drivers are used to allocate all joint costs to the respective services provided. -Costs are then further allocated to specific IUs based on demand for those services whenever possible.
<u>Budgeting</u> **-**Wastewater and Water services are generally broken out in budgets. However, each of these budget areas will often exclude costs associated with support functions. As a result, there may be substantial overhead costs that have not been linked to either business service provided.	**-**Budget breakouts for wastewater and water should include administrative support services.

Discharger Location and Multi-Plant Systems

Discharger location within a treatment plant service area can affect the cost of treatment in three main ways. First, the distance from treatment may generate higher unit costs for collection systems (more miles of pipe travelled) and may require additional pumping. Second, a large system, especially those with multiple treatment plants, may have a mix of newer and older assets that have very different technical constraints and cost structures in different parts of their districts. Large differences are common in industry. For example, the cost difference between the best and worst performing plant within a single firm can vary by a ratio of three to one. Even once technical parameters such as plant age, technology, and location are controlled for, this variation can still be as high as two to one, indicating the importance of good management in plant efficiency.[11] Finally, since a substantial portion of the cost of wastewater collection and treatment is fixed, differences in capacity utilization can have large impacts on unit costs.

Understanding and tracking this variation is important in rationalizing existing capacity. Where capacity is tight, differential wastewater fees can encourage new development to occur in a lower-utilized portion of the system.[12] These fees can also encourage discharges to conserve the scarce resources, allowing the infrastructure to last longer. Where a utility wishes to have uniform rates across the service district despite substantial variations in the cost of service, improved cost accounting can enable POTW staff to better target their pretreatment or conservation resources.

[11] Chew, W. Bruce, Timothy Bresnahan, and Kim Clark. "Measurement, Coordination, and Learning in a Multiplant Network," in Robert Kaplan, editor, *Measures for Manufacturing Excellence*, (Boston: Harvard Business School Press, 1990), p.129.

[12] Obviously, water treatment fees are but one of many variables evaluated by a company when deciding where to locate a plant.

The information can be used by managers to plan infrastructure improvements, as well. For example, one Virginia POTW linked its plants together, enabling them to average demand across the network by diverting streams whenever necessary.[13]

Exhibit 3-10

DISTANCE FROM PLANT/MULTI-PLANT SYSTEMS

Common Practice	Improved Cost Accounting/Budgeting
Cost Accounting -Discharger fees often based on the average cost of servicing all zones. POTW management may not have a good handle of differential costs of service due to asset type, distance from treatment, or utilization levels. -Although many districts have higher fees for IUs outside of the city, these rates often have more to do with political power than with differential costs of service.	-POTW should track differential costs of service based on distance or zone of the district to use either in rates or in planning. -Cost surcharges for differential service costs (such as collection and pumping) may be in order.
Budgeting -While some POTWs have separate budget information for different treatment plants, even these may not include the associated overhead costs. -Often, infrastructure costs are lumped together.	-Budget line items for specific assets to support peripheral service may be helpful. -Budget line items for specific key assets with very different costs may be helpful.

Capacity Limits to Existing Plant May Drive Up System Costs

Wastewater treatment systems are complex processes with numerous constraints. For example, collection systems can be too small to allow a district to utilize its entire treatment capacity. Treatment capacity may be too small to handle the current flow. In both of these cases, the utility can invest in expansions to solve the problem. Alternatively, cost accounting can give program managers information on which dischargers are utilizing the largest portions of the constrained item so they work with these dischargers to reduce their loadings. This is analogous to demand side management programs in electric utilities, and may be substantially less expensive than expanding supply.

Physical flow constraints are but one of many possible parameters that may limit system capacity. For example:

- Very high strength wastes may require longer residence times than standard discharges. Since throughput is equal to technical capacity multiplied by average residence time, longer residence time can use up plant capacity in the same way that large flow can.

[13] This increased flexibility comes at a cost, however. The cost of the flow diversion infrastructure is similar to capacity expansions to handle peak flows, and should be allocated to the customers causing the peaks.

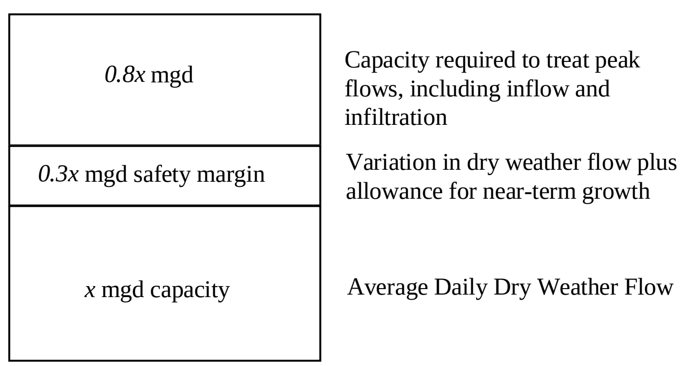
- Peak loadings in flow, strength, or other parameters, may require larger scale or more complex treatment plants, driving up costs as well. Cost accounting can help identify what customers or practices drive up peak loadings and identify ways that peaks can be reduced.

Pricing capacity is very important if the WWTP wants to send the proper signals to dischargers, encouraging them to reduce their demand during peak periods. A variety of pricing schedules have been developed in the electric and natural gas utility industries for this very reason. For example, peak prices tend to be higher than off-peak prices. Industries that are willing to be "shut off" during peaks are given discounts. Finally, the allocation of peak system costs among customers is done to try to reflect which customers drive the peak demand.

Gas utilities allocate infrastructure costs, such as distribution systems (analogous to collection systems in WWT), using the minimum size theory. The smallest scale system required to serve a standard customer is allocated to each customer. The difference between the smallest scale system and what is actually in place is allocated based on demand. Thus, larger dischargers pay a higher share of the infrastructure costs.

Exhibit 3-11

HYPOTHETICAL IMPACT OF PEAKS
ON PLANT SIZING



But on top of the larger dischargers is the issue of peak capacity. The additional cost of handling peak discharges can be substantial. Exhibit 3-11 above suggests that the required treatment capacity can rise substantially to handle peak flows. Additional collection capacity and storage facilities need to be built as well. Allocating these costs appropriately can be quite a challenge. Some rules of thumb:

- Basic capacity, plus a safety margin for normal variance in dry weather flow, should be allocated equally to all customers.

- Incremental capacity required for above-average dischargers should be allocated to customers using that capacity based on flow. There are a couple of common methods to allocate these demand charges among users to encourage peak reductions.[14]

  – *Coincident Demand Method* Also known as the peak responsibility method, costs are allocated to customers based on their demand during the time of system peak.[15] The rationale is that demand patterns at this point in time are what drive the utility to build the scale plant it did.

  – *Noncoincident Demand Method* Allocates costs based on the individual peak for each customer, regardless of when this peak demand occurs relative to the peak demand on the treatment system overall. The noncoincident demand method makes sense when the sizing of capital is driven more by the individual peak than by the aggregate peak, such as may be the case with the size of portions of the collection system.

  – *Average and Peak Demand Method.* Under this method, the average load rate multiplied by the total demand charges to yield the costs associated with average use. These costs are allocated among dischargers based on share of annual loadings. The residual costs are assumed to be associated with peak demand and allocated based on the coincident peak method.

Electric and gas utilities have long worked to manage peak demand through their rate structures. Some of these approaches have been adapted by wastewater treatment plants; others may be valuable peak management tools going forward. These are summarized below in Exhibit 3-12. A number of peak-related issues for POTWs are then presented in greater detail.

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[14] National Association of Regulatory Utility Commissioners (NARUC), *Gas Distribution Rate Design Manual*, (Washington, DC: NARUC), June 1989, p.27.

[15] To reduce the cost impact of measuring the single annual peak imprecisely, many utilities average the contributions to the top five or ten peak periods throughout the year to calculate the cost allocations.

Exhibit 3-12 DIFFERENTIAL RATES FOR PEAK LEVELING		
Issue	**Cost Impacts**	**Rate Solution**
Peak demands create need for expensive, larger scale capacity, though this capacity is infrequently used.	POTW must build expensive collection and treatment capacity to meet those peaks.	**-Interruptible rates** provide reduced charges to customers willing to forgo services during peak events. For POTWs, IUs might have storage capacity on-site enabling them to delay discharge for a week or so. **-Demand charges** based on peak consumption patterns forces consumers of peak capacity to bear most of the cost of providing it.
Seasonal populations or production drive demand far above "normal" level.	POTW must build expensive collection and treatment capacity to meet those peaks.	**Seasonal rates** charge higher rates for users during the peak season to encourage peak leveling. The coincident demand method of peak allocation accomplishes this same goal.
IU has internal treatment, but wishes to rely on POTW as a backup in case of problems with in-house system.	POTW needs to provide collection system infrastructure and capacity for an infrequent user.	**Standby rates** recover these incremental costs through fixed charges rather than through fees on discharges.
Source: National Association of Regulatory Utility Commissioners, *Gas Distribution Rate Design Manual*, June 1989, pp. 51-53.		

Inflow and Infiltration (I/I)

Wastewater treatment capacity is very expensive. While there are economies of scale in bigger collection pipes and bigger treatment plants, the absolute cost per unit treated remains high. Given these costs, the size of the entire treatment system should be built only to the size needed for the population to be served. Perhaps more than any other source, I/I drives up the capital infrastructure of wastewater treatment. I/I is comprised of a variety of sources of street runoff, combined sewer overflows, and leaks that let rainwater into the sewage system. Once these sources enter the sewer system, they require pipe capacity to be transported to the treatment plant, storage areas for when the treatment plant is at capacity, and treatment capacity to treat what used to be relatively clean water.

Storm surges can be managed through retainment basins that store peak flows, allowing it to work it's way through the POTW during the weeks following the storm event. This peak leveling technique is less expensive than building treatment capacity large enough to treat the storm peaks. However, it still requires larger sizing of collection systems and pumps, as well as the cost of building and maintaining large storage basins.[16]

I/I is a big problem. According to a recent AMSA survey, inflow and infiltration (along with stormwater that goes to the plant) comprised almost 25 percent of total flows, increasing the treatment capacity required by the same amount. This figure represents an average; values for specific plants are substantially higher.

Exhibit 3-13

AGGREGATE FLOWS OF 107 POTWS

Flow Type	Flow (MGD)	Percent of Total
Infiltration/Inflow	2,423	20.2%
Combined Stormwater	502	4.2%
Total Wet Weather to Plant	2,925	24.4%
Residential	6,826	56.7%
C&I	2,253	18.8%
Total to Plants	12,005	100.0%

Source: Association of Metropolitan Sewerage Agencies (AMSA), *The AMSA Financial Survey, 1996*, p. A-17

The costs of extra capacity to handle wet weather peaks associated with I/I should be allocated as closely to their sources as is possible. Often, the closest one can come to such an allocation is apply the costs to a particular zone of the collection system, and then allocate within that zone to each customer. However, careful costing of the I/I events can provide extremely strong inducements to correct common sources of I/I, such as manhole or sewer leakage, sump pumps, or faulty sewer connections. A detailed study of I/I control options in the Lower Paxton Township Authority in Pennsylvania is instructive, shown in Exhibit 3-14.

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[16] The placement of storage basins is also important. Placing the basins away from the plant allows a reduction in the peaking capacity required on the trunklines as well, saving additional funds.

Exhibit 3-14

INFLOW AND INFILTRATION CONTROL IN LOWER PAXTON TOWNSHIP AUTHORITY, PA

Control Approach	I/I Contribution (%)	I/I Control Costs ($/gallon removed)
Remove Sump Pumps	19	$0.04 - $0.27
Grout Manholes	25	$0.04 - $0.30
Grout Sewers	15	$0.05 - $0.36
Mainline Replacement	<1	$0.16 - $2.22
Lateral Repairs	42	$0.20 - $3.72
Equalization Basins	N/A	
-Above ground tank		$0.98
-Below ground tank		$1.32 - $4.80
Convey and Treat	N/A	
-Additional capacity at existing plant		$6.16
- Construct new plant		$3.81 - $18.80

Source: James Elliott *et al*., “Removing Private Sources of Infiltration and Inflow,” *Water Environment & Technology*, August 1997, pp. 55-60.

The implications of this specific analysis are clear. For POTWs facing capacity constraints due to I/I problems, supply-side options exceed the cost of demand-side options to reduce the inflow by a wide margin. Proper cost accounting for the cost of handling the peak flows can provide POTW managers with very clear signals in this regard, giving them leverage to implement control strategies quickly:

- **Increase Rates.** Charging I/I sources the incremental costs of having to increase POTW capacity to handle the flows would induce rapid control of the many private sources of I/I.

- **Defer Acceptance of Developer-Constructed Collection Systems.** The Pennsylvania study estimated that over 40 percent of the I/I entering the plant came from defective lateral lines. These lines are often built by developers as a condition of allowing the development to go forward. The incentive of these developers is to put in the lateral lines as cheaply as possible so that the POTW will accept the new dischargers and people will buy the new property. Often these laterals are poorly built and leak from the beginning. Armed with information on the real cost of I/I, POTW staff can refuse to accept the new laterals until they have proven to be of sound quality. The POTW can also require bonding that allows the I/I to be corrected if the laterals are problematic.

- **POTW-initiated Remediation.** Where charging I/I sources their contribution is impossible due to measurement problems or political issues, the POTW may still find it less expensive to pay for retrofits directly in order to avoid the need for new plant capacity.

Exhibit 3-15

INFLOW AND INFILTRATION

Common Practice	**Improved Cost Accounting/Budgeting**
<u>*Cost Accounting*</u> -Costs of I/I embedded in the baseline capital costs of the facility through increased scale requirements.	-As facility nears its existing capacity for wet weather flow, storage, or treatment, I/I issues become far more important. -In plants with excess capacity, incremental costs of handling I/I should be charged back to sources of I/I -- at least to zones of the system. In plants with dwindling capacity, costs of capital expansion to alleviate the shortage should be charged back to I/I sources to encourage comprehensive I/I controls. -Exceedances associated with SSOs from I/I should be charged back to I/I sources.
<u>*Budgeting*</u> -POTWs may have I/I or stormwater divisions that deal with I/I issues. However, these costs may not include administrative support needed or the costs of increased capital sizing.	-New capacity required for I/I related peaks should be budgeted and include all financing costs. -I/I operations should include supporting administrative and analytical functions.

Large Dischargers and Seasonal Peaks

The minimum size theory allocates baseline costs of treatment across all customers. Large dischargers create additional demands on the system by the sheer quantity of wastewater discharged. Collection pipes, pumps, and treatment infrastructure must all be made substantially larger to handle the additional flows. To encourage efficient decisions regarding on-site reuse or treatment versus discharge, the incremental costs of the additional equipment needs to be allocated back to its sources. Most POTWs do this in the form of a discharge fee. Peak rate pricing will spread the incremental costs of facility size across a smaller portion of the discharging universe, as a large number of customers (e.g., residential) will not exceed the level of discharge used in the minimum sizing of the system. As a result, the rates per unit discharged on these high quantity dischargers could well be higher than the rates charged for the baseline system.

The more variable these large discharges, the larger the incremental units charges are likely to be. This is because the same fixed capital must be put in place to handle a smaller annual flow. In resort areas, for example, populations can double or triple during peak months, creating demand spikes for support functions such as wastewater treatment. (Once again, the spikes for WWT are more difficult to handle than, for example, those from electrical demand, since services are difficult to import. Networking plants is one way to better absorb the peaks). Seasonal surcharges reflecting demand patterns during this peak period can help send the proper signals to dischargers to conserve capacity more during the peak months. Many POTWs increase rates only to seasonal customers. This approach, while seemingly more equitable to year-round residents, will not encourage capacity conservation by all dischargers. This may reduce the opportunities for minimizing the costs of demand reductions.[17]

Exhibit 3-16

LARGE DISCHARGERS/SEASONAL PEAKS

Common Practice	Improved Cost Accounting/Budgeting
Cost Accounting -Large dischargers are normally charged a fee per unit discharged requiring treatment (excluding surcharges for strength). -Fees for larger users vary from lower than average (a form of a volume discount) to higher than average (increasing block rates). It is difficult to ascertain how closely increasing block rates are linked to cost impacts of large discharges. -Many POTWs do not increase rates during peak seasons.	-Unit fee should be based on incremental capacity required to handle the larger flows. -Discharge fees should be higher during seasonal peaks. These surcharges should be borne by all dischargers requiring services during the peak months and not exclude year-round residents.
Budgeting -No differentiation of peak and baseline costs or revenues.	-Differentiation of peak and baseline costs would help illustrate the incremental costs of peak-increasing demand patterns.

System Expansions May Create New Challenges

System expansions create challenges for POTWs for two reasons: the large scale of most new capital equipment (capital "lumpiness"), and a pricing model that charges users the average cost of existing capacity even when adding to that capacity would be substantially more expensive. Each of these items is explained in greater detail below:

[17] Seasonal pricing is a good example of how important the timing of pricing signals is. Unless dischargers during the peak months know ahead of time that their rates will be substantially higher than normal, they will have little incentive to reduce their discharge levels through increased recycling or water conservation.

- *Capital "Lumpiness."* Wastewater treatment is a capital intensive industry with substantial economies of scale. Thus, new capacity is brought on line slowly, and in fairly large capacity "lumps." Right before new capacity comes on line, the old capacity is likely to be fully utilized, with capacity shortages. Right after the new capacity comes on-line, utilization will drop substantially, and unit costs (i.e., the capital costs per unit treated) rise significantly. While all capital intensive markets experience this dynamic to some degree, it is worse in wastewater treatment. In the paper industry, for example, a new plant can export its production over a wide area. Thus, the new capacity surplus is shared by multiple plants rather than just one. POTWs provide services in a fixed area; it is quite difficult to "import" more wastestreams to treat. Thus, the plants' operate with substantial excess capacity until new growth increases the wastestreams requiring treatment.[18]

- *Average Cost Pricing.* Because POTWs are regulated industries with rates based on their cost of service, the rates charged to customers are, in effect, the *average* cost of service. If changes in regulations, financial conditions, or construction costs make plant additions (which are the marginal costs for the utility) more expensive than the average cost of existing plants, the average cost price could be substantially lower than what the utility will need to charge once the new plant comes on line. As a result, dischargers will not get the price signals that would exist in a competitive market that capacity is becoming tight and they should do what they can to reduce their discharges.

System Expansion to New Areas/Customers

POTW expansion can bring many capacity issues to the surface. The cost of new lateral lines to service these customers should generally be borne in full by the new customers. More complicated are issues associated with how the new discharges will affect capacity requirements in trunk lines, pumping stations, and treatment plants. These impacts may be from normal discharge rates, or from new peaking demands (including I/I) from the additional load. New discharges may also affect the quality, and hence the marketability, of residuals.

A common tendency is to want the new dischargers to pay the full costs of extra capacity associated with their discharges. As noted above, unless the cost of scarce capacity is charged to *all* dischargers rather than just new ones, the proper price signals to reduce consumption of the scarce capacity will not be sent. This being said, proper accounting of the full cost of the

[18] Problems associated with capital lumpiness can be mitigated somewhat by coordinating collection system expansion with new treatment capacity construction, and by installing a series of smaller scale treatment units as demand rises.

expansion is needed to compare against alternatives. As in the I/I example above, many alternatives could be less expensive than simply expanding conveyance and treatment capacity to handle the new volume.

One key issue to be grappled with is the issue of centralization versus decentralization. For dense, urban populations, centralized treatment of wastewater is generally the most efficient approach. At some point, as collection systems are expanded into more sparsely-populated districts and centralized treatment capacity it used up, the full cost of expanding centralized treatment could well exceed that of using a smaller-scale, decentralized approach.[19] One outspoken critic of the centralized treatment model argues that many viable decentralized methods are overlooked, and that packet plants under the control of a sewerage authority, could often be used.[20] New technologies, such as artificial wetlands, are also more viable in rural areas where land is more plentiful and retention times can be increased. Technologically, unless sewerage authorities recognize the niche, off-grid opportunities for these evolving techniques, the approaches will not benefit from the trials and incremental improvements that allow them to move into the mainstream over a period of a decade or so.

Without proper cost accounting, the break-point for alternative treatment is not visible to plant decision makers. Any costs associated with extensions, including new treatment capacity, new debt issuance, and increased pumping or collection system capacity need to be compared to the cost of decentralized alternatives.

Differential Impacts of System Expansion by Customer Class

The available options for addressing new service needs can be constrained by particular types of dischargers in the new areas to be served. Unless the full costs of these special requirements are properly tracked and allocated to their causal factors, the utility may decide to pursue a less cost-effective option.

Consider the example of a large industry looking to locate in a rural area, and wanting the POTW to provide service to them. Many residential and commercial customers will receive service as well, reducing the unit costs of the extension. However, this particular industry discharges constituents that interfere with the effectiveness of the decentralized options or which contaminates residuals, precluding their local reuse. In the absence of this discharge, the entire region could be serviced at a substantially lower cost using decentralized treatment and local reuse of biosolids and effluent. In this example, the entire incremental cost of extending the

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[19] For example, two small towns, one in West Virginia and one in Virginia, realized substantial savings (42 to 65 percent) using alternative systems rather than installing a conventional WWTP. See U.S. General Accounting Office, *Water Pollution: Information on the Use of Alternative Wastewater Treatment Systems,* September 1994, pp. 3-4.

[20] See David Venhiuzen, "Paradigm Shift: Decentralized wastewater systems may provide better management at less cost," *Water Environment & Technology*, August 1997, p. 49.

centralized system over building a smaller, less complex decentralized system (plus the lost revenues on residuals reuse), should be allocated to the industry. Town development authorities may decide to go forward anyway, arguing that many other industries would soon follow; however, at least the decision would be made with an understanding of how much servicing the industry was really costing the municipality in the short-term.[21]

Exhibit 3-17

SYSTEM EXPANSION/CENTRALIZED VERSUS DECENTRALIZED TREATMENT

Common Practice	Improved Cost Accounting/Budgeting
Cost Accounting -Costs of infrastructure assets are not generally disaggregated in such a way to be able to assess the full costs of line extensions. -Incremental costs of capacity expansions may not be linked to the factors driving that need (e.g., expanding service to a new area). As a result, system expansion can't be compared to decentralized alternatives or demand-side management. -Costs associated with system expansions not always linked to specific customers or customer classes.	-Costs of scarce capacity should be borne by all dischargers contributing to that scarcity, not just to new entrants. -The total cost of system expansion, including all impacts on conveyance and treatment, needs to be compared to alternative methods to provide service. -Where these expansion costs are due to specific types of discharges or dischargers, costs should be borne by those particular entities.
Budgeting -Costs of extensions are hidden in very general capital acquisition line items.	-Budget line items should provide managers with information on the full incremental costs of system expansion.

Interjurisdictional Agreements

Many POTWs receive flows from dischargers located outside of their jurisdictional boundaries. In these circumstances, POTWs face a difficult situation: the discharges force them to incur costs and affect plant performance, yet they have no political authority over the dischargers. This issue is resolved using a contractual agreement called an Interjurisdictional Agreement (IJA). IJAs outline the rights and responsibilities of the various municipalities in the agreement (there are sometimes more than two), but often do so in a fairly legalistic and unwieldy way. IJAs do not inherently increase the distortions associated with POTW management; however, in practice they often constrain the ability of the receiving POTW to regulate dischargers or adequately recover costs. The case study of Escondido, CA in the next chapter provides additional illustration of the challenges IJAs can create.

[21] A General Accounting Office study of alternative treatment technologies found that some state and local codes actually required conventional treatment, creating a substantial barrier to the use of alternatives. Codes such as these make it hard to attract investment for system construction because not always clear if the plant will, in the end, be permitted. See U.S. General Accounting Office, September 1994, op. cit., pp. 40-43.

While IJAs can be changed, doing so requires a fairly complicated political process and is generally difficult to do. As a result, IJAs are often left in place despite their problems. Costs on a system from dischargers in another municipality may be borne in part by in-system dischargers, artificially increasing the cost of wastewater treatment to local industries.

Cost accounting can be a useful tool to highlight the cross-subsidies that an IJA may entail. By tracking the cost impacts of discharges, as described in the various sections above, and then grouping these costs for all dischargers in another municipality, POTW management can assess if cross-subsidies exist and how large they are. This evaluation will help managers determine when cross-subsidies are so large that the IJA must be renegotiated, and when improved outreach or even in-plant investment in discharger plants can have a positive return to the utility.

4. DETAILED CASE STUDIES

To augment the topical summaries, we have conducted case studies of budgeting and cost accounting systems in place at two actual POTWs.[1] The complexity associated with running a POTW is not quite as apparent in the topical summaries as when the multiple functions and systems are evaluated together. The case studies illustrate how small distortions, when combined with others in a POTW, can have a large impact on facility sizing and operations. The case studies also illustrate how the needs of, and constraints on, various groups involved with the POTW make compromises in costing (relative to the theoretical optimum) necessary. POTW managers can use the information contained here to help them strike their own balance regarding what information they collect and how this information is used relative to budgeting and rate setting. As noted throughout the report, the purpose of improved information is to enhance managerial decisions whether or not there are any changes made to rates.

We are very appreciative of the many people associated with the City of Escondido, the Massachusetts Water Resources Authority (MWRA), the City of San Diego, and the San Elijo Joint Powers Authority who were willing to give us their time and insights to make these case write-ups possible. The City of Escondido is a relatively small treatment plant with important treatment assets shared with its surrounding cities, including San Diego. MWRA is a large municipal system servicing scores of communities. It acts as a wholesaler, charging towns rather then dischargers for their services (other than pretreatment which is billed directly to IUs). This mix of facilities allows us to present a wider range of issues than would be possible with very similar POTWs.

The City of Escondido, CA

Escondido, CA is a medium-sized town located outside of San Diego. The city operates its own wastewater treatment plant, the Hale Avenue Resource Recovery Facility (HARRF). Escondido participated in EPA's evaluation of pretreatment program success factors and challenges last year, and agreed to participate in this effort as well. The city was targeted as a case study due to a number of interesting characteristics identified during last year's site visit.

- **Capacity Shortages.** The city is at or near capacity for both its treatment plant and its outfall. Careful allocation of costs, in order to encourage capacity-conserving behavior on the part of dischargers, becomes increasingly important as existing capacity is used up.

[1] Case studies are based on a contribution of written documents, telephone interviews, and personal interviews. To protect the candor of interview participants, specific comments have not been cited to individuals. Citations within the chapter are limited to written materials.

- **Sharing of Key Assets.** The city shares key program assets with surrounding communities, including the both the outfall and its treatment plant. Sharing of these resources is governed via interjurisdictional agreements, instruments that are difficult to modify and do not always send the proper pricing signals to participants.

- **Informal Conditions Associated with Municipal Discharges.** The city receives discharge from a municipally-owned water treatment plant (WTP). Although the WTP discharges have significant impacts on plant operations, the relationship between the water and wastewater plants is informal and not based on the economic value of services being provided. This type of arrangement is not uncommon in municipalities, but can make efficient plant operation more difficult.

- **Sale of Valuable Residuals Constrained by Contaminant Levels and External Government Subsidies.** Located in water-scarce Southern California, Escondido should have ready resale markets for its effluent. However, a combination of high contaminant levels (salts and metals) and artificially cheap alternative sources of fresh water for irrigation impede HARRF's ability to remarket its effluent.

While the discussion below is organized by topic areas, there are a few underlying issues that bear mentioning. The first, fragmentation of control, impedes Escondido's ability to rationalize its limited resources. Fragmentation of control dilutes management's power to regulate and control practices that affect the operation of its plant. In the city of Escondido, fragmentation issues affect its pretreatment program, its optimization of key assets (such as the treatment plant and the outfall), and the resale of effluent. Although cost accounting approaches can help the POTW to identify the costs of existing practices as well as more efficient solutions, the fragmented control will require political action to rectify. Staff were well aware of the rigidities that this fragmentation created for their program; on more than one occasion, interviewees remarked that long-term planning and expansion would be much easier if the region were organized as a special utility district rather than governed through interjurisdictional agreements.

The second common theme in many of the Escondido areas examined is that of full cost recovery. This includes not only the recovery of aggregate costs from dischargers, but the use of peak pricing to allocate these costs more directly to specific dischargers. In some cases, the POTW did not know the full costs of particular activities. Even where they did have a rough idea of the full costs, however, managers knew that political realities prevented them from passing these costs back to the parties responsible. In an effort to create a "business-friendly" environment in the town, managers were under great pressure to keep rates to industry low. Escondido has relatively small flows from industry.

However, their concerns about being business friendly echo those we have heard from many other programs where IUs flows are much more significant. Without sending the proper price signals to industry, water pollution will continue to be subsidized, and industries will underinvest in pretreatment.

General Approach Towards Cost Accounting and Budgeting

Escondido's focus in the cost accounting arena has been on separating water and wastewater costs, and on ensuring that existing users don't bear the costs of new capital expansion triggered by new users. With these goals in mind, the city set up separate water and wastewater enterprise funds, with a statutorily-defined separation of accounts. Funds can not be transferred from one account to another without utility board approval and the creation of a formal loan agreement. This arrangement prevents cross-subsidies between water and wastewater operations, as well as protects any wastewater surpluses from being raided by other municipal functions, a frequent complaint in other cities.

The POTW relies on the city government for many of its support functions, such as administration, finance, engineering, legal, management and information systems (MIS), and human resources. Costs for these functions are allocated to wastewater operations based on the number of staff-hours spent on wastewater activities. Such an approach, while a reasonable approximation of costs, may be inaccurate for activities where capital is a large cost component, such as MIS.

The separation of funding sources into existing customers and new connections for capital expansions helps to ensure that the existing customer base does not bear the cost of new growth in the community. New construction is funded through a flat capacity (currently $4,403) charge per equivalent dwelling unit or "EDU". One EDU allows a customer to hook into the sewer system and discharge up to 250 gallons per day. The rationale for this approach is that the older customers have already financed the infrastructure in place and should not have to pay for the upgrades as well.

The EDU approach has proven extremely useful in allowing Escondido to expand during times when it could not easily borrow on capital markets. As implemented, the new connections fee also ensures that older customers do not bear the cost of extending the collection system to new users, which makes sense. However, some of the other price signals that the EDU approach, and the new connections fund in general, send have a couple of weaknesses. First, all projects related to new connections are lumped into a single pool, creating the possibility of cross-subsidies within this group. Such cross-subsidies can hide important break-points, such as where decentralized treatment becomes more economic than sewer line extensions. Second, where common assets (e.g., a trunkline) becomes constrained due to system expansion, increasing the rates only to new customers will not send the proper price signals to all users of that scarce capacity, some of whom may be older customers who are able to cut their discharge at a lower per unit cost than new users. Third, dischargers are not able to sell their EDUs back to the system or to other users if they cut their discharge. As a result, they have somewhat less of an incentive to invest in technologies that reduce their need to discharge to the sewer system.

Escondido has experimented with a number of budgeting techniques. Zero-based budgeting, where every program must justify its entire allotment annually, proved too disruptive to staff. Two-year budgeting, predicated to shift the annual budget-period crunch into a two-year affair, was also problematic. They had a very difficult time projecting needs one year in advance; two years was even worse. Finally, the city tried program-based budgeting, which is similar to activity-based costing. With over sixty cost pools to project, they found the process too unwieldy. Managers also felt that their projections were simply guesses that did not provide them with additional decision-making data.

As a result, they have continued to use an annual budget process with expenses grouped into very general categories. Programmatic data continues to be collected even though it is not used in budget development. Rather, spending is tracked by the program/project areas, some of which are shown in Exhibit 4-1, and given to managers in monthly reports. Exhibit 4-1 shows only the program area name; the city also assigns each a tracking number. This system has enabled the city to provide key information to managers without making their budgeting process unduly complex. The city recently integrated labor-hour tracking by project as well, vastly improving its ability to cost out the resources used on particular activities. Managers have found this addition extremely useful in understanding the dynamics of their programs.

While the project-based tracking greatly improves the information available to managers, there are many gaps in the data. For example, it remains somewhat difficult to aggregate spending by program aspect. Some program areas, such as oil and grease management, are not broken out separately. In addition, capital infrastructure or O&M costs have not been allocated to their causal areas. Thus, all capital projects required handle I/I systems are not easily tracked back to I/I using the existing budgeting accounts. Similarly, O&M due to grease blockages would likely show up under “Lateral Maint/Repair” or “Jet Rodding/Vacuum” without being linked specifically to oil and grease dischargers.

Exhibit 4-1

SAMPLE PROGRAM AREAS TRACKED BY ESCONDIDO WWT PROGRAM

Program Area	Program Area	Program Area
Liquid Processing Maint.	Equipment/Shop Maint.	Ind Waste Comp Mon - Escon.
Solids Handling Maint.	Force Main Maint./Repair	Ind Waste Comp Mon Ran Bern.
Reclaimed System Maint.	Lift Station Maintenance	Reclaimed Water Testing
Electrical	Lift Station #7	Water Reclamation
Instrumentation	Over Flows & Emergencies	Solid Sampling/Testing
Co-Generation Maint.	Service Requests	Copper/Lead
HARRF Grounds Maint.	Large Sectional Twister	Well Water
Building Custodial Maint.	Manhole Inspection	Misc. Sampling and Testing
Safety Equipment Maint.	Easement Maintenance	QC-QA Testing
Equipment/Shop Maint.	Confined Space Maintenance	Laboratory Administration
Influent Pump Station	Trench Compaction	Water Connection Rights
Lift Station Maint.	Pretreatment Reporting	Water Reclamation Admin.
Lift Station Grounds Maint.	Bernado/Ham. Assess. Dist.	Environmental and Safety
Land Outfall Maintenance	Liquid Process Operations	
Jet Rodding/Vacuum	Solids Handling	
Twisting	Industrial Waste Adm. & Test.	
Televising	Storm Water Testing	
Locates	Laboratory Services	
Manhole Maint./Repair	Wastewater Testing	
Lateral Maint./Repair	Ind Waste Test - Escon.	
Mainline Maint./Repair	Ind Waste Test - Rancho Bern.	

Source: City of Escondido Program Chartfield Definitions, 1997.

POTW managers have established some flexibility in their budgeting process. For example, although all wastewater revenues go back into the general wastewater fund, within wastewater operations, there is some flexibility to shift funds among accounting line items as needs arise. There is also a multi-year contingency fund used for emergency and surprise expenses. Capital budgeting is done annually, although the POTW also utilizes a five year planning cycle for major capital upgrades. The POTW does not have a formal process of depreciating capital equipment and accruing for replacement during its life. Rather, most of the capital replacement is funded through a somewhat undersized "miscellaneous major maintenance" line item (that allows for replacement as well as maintenance). As a result, a number of staff felt that they never had enough funds to replace their aging plant (though the POTW works hard to ensure that staff have updated analytical tools).

Managing and Optimizing Key Shared Assets

More than many POTWs, Escondido shares key assets with surrounding communities. Substantial flow comes from the Rancho Bernardo district of San Diego, and San Diego contracts with HARRF for capacity. The outfall pipe used by the city to discharge its treated effluent is comprised of a land portion, owned by Escondido, and a water portion, owned by the San Elijo Joint Powers Authority. The city has an agreement with San Elijo for 79 percent of the water outfall capacity. The land outfall is implicitly shared with San Diego, as Rancho Bernardo flows to HARRF must the be discharged through the outfall.

Capacity in the outfall is already constrained, and is insufficient to meet demand during storm events. Some, though not much, spare capacity remains at the treatment plant. The city relies on equalization basins, used nearly to capacity, to allow the existing dry weather flows to be treated within the existing capacity at HARRF.

Current arrangements for sharing capacity are through interjurisdictional agreements among the participating parties. These specific agreements have three main problems:

- **Difficult to Modify.** IJAs are negotiated among municipalities and rarely modified. Changes in the peak or average discharge profiles of participants are difficult to integrate into the contracted discharge allowances.

- **Financial Arrangements Do Not Reflect Actual Costs of Capacity Used.** Payments for both the treatment and outfall capacity are based on the proportion of *average* flows from the participating parties that are sent through HARRF and the outfall. In fact, it is *peak* flows that drive much of the capital requirements for the infrastructure. While there are restrictions on the peak flows that may be discharged, these restrictions are difficult to enforce and do not have associated financial penalties.

- **No Surcharges for Constituents of Concern.** Flows received from other municipalities are not surcharged. For example, Escondido receives waste flows from a San Diego experimental treatment plant that uses water hyacinths. When these plants are compressed at the end of the treatment process, the compression releases salts and metals, and the discharge has a higher than average BOD. The constituents of the discharge can affect the cost to process and/or the value of residuals; charges should reflect these impacts.

The impacts of some of these limitations on the incentives of particular dischargers are not as perverse within Escondido as they could be in other municipalities operating under legalistic IJAs. For example, a central problem with a lack of peak pricing is the reduced incentive to curb I/I, often a major component of peak flows. Yet, recent I/I studies in Escondido, San Diego, and San Elijo service areas suggest that no single community is responsible for a disproportionate share of I/I. The implication is that the use of average rather than peak flows is unlikely to substantially distort relative charges. In other regions, this may not be the case, and substantial sums may be spent to increase plant capacity due to improper pricing of capacity.

Nonetheless, some of the tools discussed earlier in this report can be usefully applied to make IJAs more flexible. For example, resource pricing techniques could be used to quantify the value of the scarce outfall or plant capacity, allowing capacity allocations to be done via pricing rather than contractual fiat. This approach would ration the scarce capacity to the parties that need it most. The fact that each party would have to pay for the capacity it used would encourage each to implement steps that reduced flows during peak periods -- whether through better I/I control, improved equalization capability, or other means.

Controlling Constituents of Concern with Fragmented Control

POTWs are biological processes, designed to break down organic matter in sewage into non-hazardous, reusable by-products. The plants are unable to treat inorganic constituents such as metals or salts; these pass through the plant or are entrained in the biosolids. At high enough concentrations, these contaminants can interfere with the plant's biological process and/or render by-products unusable.

To ensure that influent concentrations of these constituents do not harm the plant or contaminate residuals, EPA required pretreatment to remove these constituents from industrial discharges. The focus has been on industrial dischargers, as these are the largest sources of most elements of concern. Pretreatment programs set limits on allowable concentrations and enforce these limits through plant inspections, analytical monitoring, and litigation where necessary. The specific limits set by a plant vary depending on the specifics of the treatment plant, the receiving water, and the NPDES permit. Fragmented control in Escondido's program makes it more difficult for them to curb constituents of concern and to send the proper price signals to dischargers. Areas where this is a problem include oversight of dischargers in the Rancho Bernardo service area, effluent from a municipally-owned water treatment plant in Escondido, and increasing concerns over brine loadings from non-industrial dischargers. Fragmentation of control and distorted price signals are also central factors in impeding the sale of treated effluent in the region.

Pretreatment

The Rancho Bernardo district of San Diego has rights to discharge 5.3 mgd of a total 16.5 mgd of capacity at HARRF, nearly one-third of the entire plant capacity. Industrial discharge from Rancho Bernardo is over 500,000 gpd, more than twice that from industries within Escondido. In addition to the general issues regarding peak flows from Rancho Bernardo overall, discharges from industries located there are important sources of contaminants such as chloride, sodium, flouride, and boron.[2]

All of these contaminants from Rancho Bernardo impede effluent reuse and require treatment by HARRF. Nonetheless, it is the city of San Diego that oversees the industrial dischargers in that region, including permitting, inspections, and charges. To address HARRF compliance with its NPDES permit, the San Diego pretreatment staff incorporate Escondido's local limits into the permits they write for Rancho Bernardo industries. However, fees levied on IU discharges reflect the standard rates charged to IUs throughout San Diego, and bear no relation to the costs that these discharges create for the recipient treatment plant in Escondido. Escondido has extremely limited ability to independently verify reported discharge levels through surreptitious monitoring or independent inspections.

While both Escondido and San Diego expressed an interest in transferring the pretreatment program to Escondido, San Diego pretreatment staff felt that political concerns would prevent such a transfer. Nonetheless, some improved tracking of the impact of Rancho Bernardo discharges on Escondido collection and treatment costs would be a powerful weapon in renegotiating the IJA or altering the charges for service.

Municipal Dischargers

Government entities often have a very difficult time regulating or charging other government entities. This issue arose during our site visits last year, where one POTW had spent years figuring out an effective way to oversee a large military discharger in their district. In Escondido, it is not the military but a water treatment plant (WTP) that creates the challenges. Since both HARRF and the water treatment plant are owned by the city, their relationship has historically been governed by informal negotiation rather than more formal assessments of the impact that one has on the other. This approach can be effective for relatively small, lower cost adjustments. However, where the impacts are larger (or not well quantified) the resistance to changes that disrupt operations or substantially increase costs to one party increase.

[2] Rancho Bernardo percentage loadings are 18 percent for chlorides, 38 percent for sodium, 90 percent for fluoride, and 74 percent for boron. HYA Consulting Engineers, *City of Escondido Brine Management Feasibility Study*, August 1995, p. 48.

Consider the specific case in Escondido. The WTP discharges about 50,000 gallons per day to the WWTP for which it is directly charged nothing. Rather, an imputed value of services is charged using allocations between municipal accounts. This allocated charge does not incorporate the real cost of the WTP discharges, and hence may not encourage them to install processes that minimize the constituents of concern. At 50,000 gpd, WTP flow is not a major issue. Rather, it is manganese and solids loadings that are a problem. The WTP is the source of 85 percent of manganese loadings at the WWTP, a result of the use of a manganese-based settling compound in the water plant. These levels may impede the ability of HARRF to resell its effluent. The high solids content of the effluent is considered by many wastewater staff as a significant factor in the need to purchase a new digester at their plant. In neither case has a careful cost accounting been done to evaluate how much treating the effluent from the WTP plant really costs the WWTP.

Were such a study to be done, a more formal financial arrangement for discharges from the WTP might spur behavior change. Although the WTP is currently evaluating ways to reduce Mn loadings, this transition might occur more quickly if financial incentives were in place. Similarly, alternative management of solids in the face of high surcharges might, in conjunction with reductions elsewhere in the system, have enabled the city to avoid the purchase of the new digester. Even if no behavior change were possible, modified charges to reflect the real cost of treating WTP residues would be passed onto WTP customers, such as irrigators. These additional costs would then be borne by the commercial beneficiaries of the service, rather than by WWTP customers as is now the case. By increasing the cost of fresh water to better reflect the costs of providing it, the surcharges would also help to spur demand for the use of reclaimed water in irrigation.

Resale of Treated Effluent

Fragmentation of control becomes an even more serious problem when it occurs on a large scale across various levels of government, as is the case in the interaction of fresh water delivery and effluent reuse. Located in water-scarce Southern California, Escondido would seem to be in an ideal location to market its treated effluent. Demand for irrigation water, not only for agriculture but for parks and golf courses as well, is high. Yet, the city has discovered that their apparently ideal market is not entirely ideal. This is partly because the city needs to reduce certain contaminants in their effluent (e.g., flouride, boron, salt). However, much of the problem has to do with the poor functioning of fresh water markets in the region. There are pervasive subsidies to agricultural use of fresh water which, as noted by a number of Escondido personnel, greatly reduce the interest of farmers in trying to use reclaimed water.

Consider the case within Escondido itself. According to utility officials, the cost to purchase water for local consumption is close to $429 per acre foot. Although the quality of this water differs substantially in salt content (depending on whether its source is Northern California or the Colorado River), there is no difference in the price that the city must pay for it. This lack of differentiation provides little incentive to try to reduce the salt content of water flowing in the Colorado.

The base rate for sales to regular customers is $524 per acre foot. With water treatment costs of $40 per acre foot, this leaves little room for the cost of constructing and maintaining the water delivery infrastructure. In comparison, agricultural users pay the city only $371 per acre foot, *less than it costs the city to buy the water.* Part of this subsidy is provided by the city; most is provided by the Metropolitan Water District, ostensibly because the farmers' water supply can be interrupted in a drought. However, unlike private utilities which actually do cut off interruptible supplies immediately, municipal supplies to farmers have not been cut off entirely, even in deep drought.

The purpose of this example is to provide a clear demonstration of the environmental distortions that cross-subsidies can create. Rather than farmers pooling together to buy reclaimed water from POTWs in Escondido or similar cities, helping to pay to reduce constituents of concern if necessary, the POTW finds little interest from its largest potential customers. Repeated throughout Southern California, or through the Southwest overall, these cross-subsidies lead to overconsumption of fresh water and a suppression of what should be strong economic drivers to recover and resell WWTP effluent, using pretreatment or other methods to control concentrations of salts and metals entering the plant. The same tools that help a single POTW identify its true costs to provide wastewater services can be used by water treatment plants and water delivery systems to price their products, a process that would encourage more rationale use of fresh and reclaimed water in the region.

Non-Commercial Dischargers of Constituents of Concern

Interestingly, Escondido faces increasing challenges in controlling even the salts that are added to *its* effluent by local water softening. The pretreatment program was set up to curb industrial discharges. Controlling constituents of concern from residential discharges is much more difficult, given their decentralized origin and the focus of existing statutes on the industrial sector.

There are two major types of water softening services. Automatic softeners are installed in residential or commercial properties, with salts added by the property owner. Brine discharges are flushed into the sewer system, increasing salt loadings into the POTW. Tank exchange systems are brine tanks supplied by a third party, and replaced periodically with a new one. The tanks are recharged at a central location. Although tank exchange firms also discharge brines to the sewer system, they can reclaim a higher proportion for reuse and are regulated as IUs by the POTW while the homeowner is not. As a result, salt loadings can be more easily controlled. For example, Escondido is planning to build a brine diversion line that would avoid contaminating POTW effluent with salts. Such a diversion line is relatively easy to install for a small number of industrial brine dischargers, but prohibitively expensive if it must connect to every home or business with an automatic water softener.

To prevent problems with salt loadings from residential and commercial customers using automatic water softeners, Escondido banned these machines. A similar ban was implemented by many communities in Southern California. Recently, a trade association representing the automatic water softener manufacturers successfully struck down the ban in a law suit. Led by Culligan, a major manufacturer of this equipment, the association declared that their victory invalidated all of the other rulings (though this was not clear from the judgment), and began selling automatic softeners to residential customers in all of the previously banned areas. A copy of a memo distributed by the Water Quality Association explains their marketing strategy in detail. As the memorandum provides interesting insights into the evolution of what is likely to be a substantial barrier to water reclamation in the future, we have included it as Appendix A.

Legally, the city of Escondido is fairly limited in the actions that it can take to control the discharges. The longer the period of time for a residential user base of automatic water softeners to grow, the more difficult controlling the brine levels in effluent will be. Yet the financial implications of this trend are significant. In addition to the planned industrial brine diversion line (costing over $1 million), Escondido is building a water reclamation plant at a cost of $46 million. Unless non-IU brine discharges can be controlled, these large capital projects will not be able to deliver the low-salt effluent needed for resale. Better cost accounting for the cost impacts of brine dischargers on system economics would certainly help the city to make the case against the automatic softeners or brine discharge into the treatment plant in general.

Full Cost Recovery

Escondido managers stated that they try to set rates that will recover the full costs of their programs, and have been successful in ensuring that overall wastewater costs are not subsidized from general tax revenues. However, they acknowledged that going beyond this to full cost recovery from particular types of customers was much more difficult due primarily to a “business friendly” environment. This pressure is faced by many programs around the country. Yet, these same businesses must pay market rates for all of their other production inputs; it is unclear why wastewater treatment should be different.

Within Escondido, industrial dischargers pay a flat fee per 1,000 gallons. There is no surcharge for constituents such as TSS or BOD because the flow from these dischargers (less than 2 percent of the total) is too small to be worth the extra effort to surcharge. There is no attempt to recover the cost of permitting the facilities either. Oil and grease dischargers, such as restaurants, pay a flat fee of $160 per year, plus a fee per 1,000 gallons of wastewater sent to the sewer. This fee covers less than 2/3 of the cost of the direct time spent monitoring and inspecting oil and grease permittees. The efforts of program staff have cut the number of overflows and stoppages due to oil and grease in half over the past ten years. However, staff did note that if the costs of addressing the clogs were allocated to oil and grease dischargers (a calculation they did not have the information to make), the permit fees would cover an insignificant portion of the total program costs.[3] Finally, as noted above, the POTW does not attempt to recover the full costs of servicing peak demand from the dischargers responsible for creating these peaks.

These existing charges reflect a host of factors. Some represent estimates of full cost recovery fifteen years ago, but have not been updated. Others reflect an estimate of reasonable charges in the face of incomplete information on the real cost of particular types of discharges or activities. Many others simply reflect a political agreement about what is fair or acceptable by particular constituent groups within the community. While these reasons do not correspond to economically-efficient pricing, they do reflect the political and organizational realities faced by hundreds of POTWs across the country. Given these realities, changing the rates overnight is not a possibility. However, if the POTW itself can better understand the magnitude of subsidies and cross-subsidies within its operations, it will be well positioned to prioritize its outreach and utility-financed upgrades. It will also be in a better position to gradually adjust rates over time.

Massachusetts Water Resources Authority (MWRA), Boston, MA

MWRA provides wholesale water and wastewater services to a large network of communities in the Boston area. Forty-five communities, comprising an aggregate population of 2.5 million people, purchase MWRA's wastewater transport and treatment services. MWRA owns three treatment plants: the recently constructed Deer Island treatment plant, which provides primary and secondary treatment with enough capacity to replace two older primary treatment facilities; the Nut Island treatment plant (scheduled to be taken out of service in 1998); and a smaller, decentralized facility in Clinton, MA providing service to two communities. MWRA's capital upgrade has been ongoing for the past several years. Once complete, this new plant will have a primary peak hourly capacity of 1.27 billion gallons per day (mgd) and a peak secondary hourly capacity of 788 mgd.[4] Several characteristics of MWRA's system and operations related to cost accounting and budgeting contributed to the selection of MWRA as a case study:

- **Role as a Wholesaler**. MWRA establishes a wholesale rate structure used to bill the communities within its service area. The incentives within MWRA's rate structures may not necessarily pass

[3] Aside from grease removal, the city flushes portions of its collection system known to clog frequently every three months rather than their norm of every 18 to 36 months.

[4] MWRA, *Fiscal Year Proposed Current Expense Budget*, February 24, 1997, p. III-38.

through to individual users, as it is up to individual communities to set local user charges. MWRA centralizes controls in some operational areas (such as pretreatment) to ensure better control over its treatment system.

- **Challenges of Managing a Large and Spread Out System**. The size of MWRA's service area and the variation among communities within the service area create a complex series of factors for MWRA to consider in decision making, including variations in the cost of service and the ability to pay for service.
- **Reliance on an Old Collection System**. The collection systems within many of the service area communities, as well as many of the interceptor mains owned by MWRA, are predominantly very old and in need of repair or replacement. Cost accounting systems that help to prioritize system maintenance and replacement become extremely important.

Themes underlying many of the issues we highlight here are the management challenges that increase with the size and reach of the POTW, and the difficulty in establishing the proper price signals for optimizing plant efficiency and protecting the environment. These issues are discussed in greater detail below.

General Approach to Cost Accounting and Budgeting

With an annual budget of $900 million (capital and operating combined) and capital upgrades with a total cost measured in the billions,[5] sophisticated financial control systems are imperative in order for MWRA to function. Although the Authority does receive some financial assistance through state and federal grants or loans, the vast majority of its capital funds must be borrowed on capital markets. Without accurate and transparent financial reporting, the Authority would never be able to borrow funds. To ensure accurate budgeting and financial reporting, MWRA has its own internal finance department with a budget of nearly $4 million per year. The administrative function of the sewerage division, with a budget of $2.6 million in FY95 and which is separate from the MWRA-level finance group, has its own finance unit as well, responsible for budgeting, financial control, and long-range planning.

MWRA prepares its accounts in compliance with Governmental Accounting Standards Board (GASB) procedures for an enterprise fund. GASB procedures provide

[5] Although the construction of the Deer Island project is nearing completion, the Authority is projecting total capital improvements worth $3.0 billion between FY 1998 and FY 2007. Capital improvements over the next three years for the wastewater system alone are estimated at $680 million. (See MWRA, *FY98 Proposed Current Expense Budget,* pp. I-23 - I-26).

outsiders (primarily investors) with the information they need to assess the financial health of the Authority. Key elements of MWRA's reporting include:[6]

- **Accrual Accounting**. The Authority recognizes revenues at the point in time they provide services, and expenses at the point in time they receive services. As noted in Chapter 2, accrual accounting is especially important in the area of capital budgeting. MWRA depreciates its capital purchases over their estimated service life, allowing them to better reflect the annual cost of capital services used.

- **Recognition of Liabilities Incurred.** MWRA recognizes and reveals liabilities or potential liabilities they have incurred in the course of their current operations if they could affect their financial health or cost of operations. Some examples include long-term lease obligations, law suits, environmental liabilities, or exposure to losses on risks that they have self-insured for.

- **Audited Financial Statements.** MWRA prepares financial statements that are audited by an independent auditor.

Although much larger than Escondido, there are some similarities in their approach to budgeting. For example, an important concern within MWRA has been to create separate sewer and water accounts, as required by its Enabling Act. Transferring funds between the sewerage division account and the water division account requires approval of the Board of Directors. This separation is particularly important in those municipalities and joint authorities, such as MWRA, that do not provide sewer and water services to the same universe of customers. In MWRA's service area, some communities receive one service, others receive both. MWRA's budget documents reflect this separation.

The Authority prepares both a detailed current expense and capital budget on an annual basis for the sewerage division. The current expense budget provides information in two ways. First, data are broken out by line item, such as wages and salaries; maintenance; professional services; etc. Second, this same budget information is broken out by program area. These program areas are shown below in Exhibit 4-2.

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[6] See Ibid., Appendix D, "Massachusetts Water Resources Authority Financial Statements and Supplemental Schedule, June 30, 1996 and 1995."

Exhibit 4-2 PROGRAM AREAS IN MWRA SEWERAGE DIVISION
-Administration -Facilities Development -Residuals -Toxic Reduction & Control -Environmental Quality -Wastewater Engineering -Wastewater Construction -Transport -North/South Wastewater Treatment Processes (main treatment plant and pump stations) -Clinton Wastewater Treatment Plant
Source: MWRA, *FY98 Proposed Current Expense Budget*, p. II-5.

The capital budget provides a three-year, detailed assessment of anticipated capital improvements, and a less detailed projection going out ten years. Projects within the overall Authority are grouped by program area (Boston Harbor Project, wastewater, water, business and operations support). There is one additional category, contingency, which makes allowances for unanticipated costs for the proposed projects. The contingency is estimated at roughly 9.5 percent of the budgeted projects.[7] Within the Sewerage Division, projects are further grouped by category, including interception and pumping, treatment, Deer Island on-going capital improvements, residuals management, combined sewer overflows (CSOs), and other. The budget then provides project-specific information on each planned capital improvement.

With a much bigger service base than Escondido, many of the support functions (such as engineering, legal, etc.) which Escondido relied on the city to provide are separate divisions within MWRA. This includes departments such as Human Resources and Public Affairs. Staff in these functional areas are also sometimes included within some of the operating divisions. Despite the assumption of these functions within the utility, cost accounting issues regarding how to allocate support function costs to water and wastewater customers remain. This allocation is important. In the proposed FY1998 budget, for example, allocated support division and other indirect expenses total $42 million, 27 percent of the sewer division's $154 million in total O&M spending.[8]

The massive investment into new plant and equipment by MWRA has resulted in more than a 500 percent increase in combined water and sewer charges for MWRA customers between 1986 and 1993, increasing water and sewer charges to some of the highest in the country.[9] Who would pay for the upgrade became a hot political question in

[7] MWRA, *Proposed FY98-00 Capital Improvement Program*, December 30, 1996, p. 3.

[8] MWRA, February 1997, op. cit., p. I-40.

[9] Ibid., p. I-34.

the Boston area, and forced MWRA to revise its rate methodology (discussed in greater detail below) very carefully. The rate methodology finally approved resulted from a detailed evaluation of options given political and technical constraints, and much consensus building. The data to support this rate structure relies on the allocation of costs to specific functional areas and then to customer classes. However, the allocations involve numerous approximations and averaging of costs; significant cross-subsidies remain that reduce the incentives for important dischargers to invest in pollution prevention and flow reduction technologies.

Dilution of Price Signals

A central focus of this report has been on accurately tracking the cost of providing wastewater treatment services in order to send the proper price signals to staff and to dischargers. In a private market, price signals pass relatively unhampered through multiple layers of intermediaries. This is because competition constrains passing through too much, and the requirement to earn a profit in order to stay in business prevents passing through too little. Wastewater treatment is different.

If communities made rate structure decisions purely on economic terms, price signals from MWRA's wholesale rates would reach individual dischargers. Higher charges to the town due to TSS, BOD, or high peak flows would be passed back to the sources of these problems, encouraging future investment to reduce the factor(s) of concern. However, once political considerations influence the process by which local rates are established, the impact of MWRA's rate methodology is often distorted. Thus, even if MWRA could perfectly track its costs and translate them into charges to communities, there is no guarantee that the communities would set rates that sent the same signals to the key dischargers. Some of the problems that arise are presented below.

Using its wholesale rate methodology, MWRA recovers the funds it needs to cover expenses from its member communities. Charges on water and wastewater are calculated separately. They are calculated annually and paid to MWRA in quarterly installments. It is then up to the member community to levy charges on its citizens. In most cases, cities must add their internal cost of wastewater services, in terms of installing and maintaining local sewer collection systems, to MWRA's charges. These two elements become the basis of charges ultimately paid by local dischargers. A number of distortions in residential rates are common, though not all apply to every community:

- **Infrequent billing.** Retail customers receive bills as infrequently as twice a year, unlike most other utilities (oil, gas, telephone, electric) where bills are sent monthly. This reduces the ability to reflect seasonal variation in fees or to quickly rectify hidden changes in consumption patterns (e.g., leaks).

- **Payments by landlord rather than service consumer.** Both water and wastewater bills are sent to the property owner not to the party consuming the water and wastewater services. While this system enables unpaid sewer bills to become a lien against the property, it also dramatically reduces the incentive of those living in rental properties to reduce their consumption of water (and hence discharge of wastewater).

- **Average of peak and strength surcharges.** Retail customers generally pay an average amount per hundred cubic feet (equal to 748 gallons) discharged. This amount reflects an averaging of all peak and strength surcharges levied on the city, reducing the incentive of any particular user contributing to these peaks (including industrial users) to reduce them.

- **Hidden charges for wastewater treatment**. Although much less common than it once was, some towns include the capital portion of water and wastewater charges with the property tax bill levied on homeowners. This approach can make the actual charges for wastewater services more difficult to see if the water/ wastewater element is not listed separately, and hence weakens the ability of prices to trigger desired behavior changes, such as reduced water consumption.[10]

- **Derived consumption.** In most cases, retail wastewater charges are calculated based on a fixed percentage of water consumption, since it is not directly metered at the point of discharge. This system penalizes customers who use large amounts of water for non-sanitary purposes (e.g., irrigation). Many towns do not allow separate metering for irrigation water.

Wholesale Rate Methodology

The translation between MWRA's costs and its wholesale charges, in and of itself, involves a number of trade-offs and potential distortions in the rates charged to towns. This level of price distortion is in addition to the dilution in price signals described above. We first provide an overview of this rate methodology, and then discuss some of the potential issues with it.

Reflecting the fact that the cost drivers for capital equipment are not necessarily the same as those for operating expenses and maintenance (O&M), MWRA uses a

[10] Including the capital charges with town property taxes enables residential consumers to deduct the payments from their federal income taxes.

different method to calculate the rates for each. MWRA's "Sewer Cost of Service Methodology" identifies "functional areas" (e.g., pumping, treatment, residuals management) which cause MWRA to incur operating costs and/or capital costs in wastewater collection and treatment. The costs associated with these functional areas are then allocated to "Cost Causative Factors" (e.g. wastewater volume, TSS, and BOD) to develop average O&M and capital costs of wastewater service. MWRA costs of service are updated annually as part of the Current Expense Budget development process.

O&M costs are allocated using total annual metered wastewater flow, total annual average strength, septage, and high strength flow loads. As shown in Exhibit 4-3, flow is the largest determinant of O&M charges, comprising nearly 60 percent of the total. This reflects the importance of the quantity of wastewater in driving operating costs. Measures of strength such as TSS and BOD increase solids loadings and residence times for treatment, and thus comprise the remainder of O&M charges. MWRA's wholesale rate methodology also allocates costs to municipalities that have high strength users. A high strength user is a permitted industry discharging 25,000 gallons per day and having an average TSS and/or BOD strength of 400 mg/l or greater. For FY98, seventeen high strength users were allocated wholesale sewer charges as part of the annual sewer rate setting process. The surcharge rate above 400 mg/l for either TSS or BOD is constant, however, for all levels of discharge.

Capital costs are allocated using metered wastewater flow and loadings, along with population. Capital costs are, by their nature, fixed whether or not the capital capacity is being used. For this reason, MWRA has incorporated two other elements in its capital rate structure. Monthly peak flow is an attempt to reflect the additional capital demands required by peak surges, and comprises about 15 percent of total charges. Population is used to allocate the vast majority of capital costs, 75 percent of the total. Population served drives both the collection system required and the provision of surplus capacity to address future growth.

The wholesale rate structure includes two important potential distortions. The first involves peak flow surcharges. While MWRA has implemented some degree of peak pricing, peak dischargers may still be cross-subsidized by other users. The second involves the allocation of such a substantial portion of capital costs on the basis of population. Allocating the bulk of capital costs based on the number of people may overlook other sources of high cost infrastructure such as peak flows or length of trunklines.

While we analyze these distortions in greater detail below, it is important to draw a distinction between cost allocation in situations of scarcity versus situations of adequate or excess capacity. Consider the case of I/I. MWRA has already built the necessary treatment capacity to handle high I/I levels. This infrastructure must be paid for whether or not it is used. Thus, eliminating pricing distortions, if it led to large investments by

Exhibit 4-3
MWRA Rate Factors as a Percent of Total Charges (FY 1998)

Factor	O&M Costs ($000s)	O&M Costs (%)	Capital (Debt Service) Charges ($000s)	Capital (Debt Service) Charges (%)	Source
Annual Flow	83,048	58.2%	-	0.0%	
Total Suspended Solids	35,112	24.6%	6,124	5.0%	
Biochemical Oxygen Demand	24,498	17.2%	6,129	5.0%	
*High Strength Component**	*2,770*	*1.9%*	*513*	*0.4%*	
Monthly Peak Flow	-	0.0%	18,335	15.0%	
Population	-	0.0%	91,765	75.0%	
Total	142,660	100.0%	122,353	100.0%	(1)
MWRA Inflow and Infiltration as a Percent of Total Flows				60%	(2)

Notes:
*Reflects high strength surcharges for flow, TSS, and BOD. Amounts already included in category totals.

Sources:
(1) MWRA, "MWRA's Sewer Service Cost Allocation Methodology," July 15, 1997.
(2) MWRA, "1997 Update on Infiltration/Inflow Reduction Strategy," Draft, August 6, 1997, p. 2.

communities to curb I/I, would simply shift the costs of the plant to the remaining users. In contrast, had MWRA (or its predecessor the Metropolitan District Commission) sent proper price signals about I/I beginning 20 years ago, investments by communities may have enabled the current Deer Island plant to be smaller, saving substantial costs.

Peak Flows

Under the current wholesale rate structure, peak flows pay only fifteen percent of capital charges. In fact, however, inflow and infiltration, a large source of peak flows, comprises approximately 60 percent of average daily flows (the average value in a survey of 107 POTWs nationally was 25 percent).[11] A year-round average understates the impact of the problem because peaking capacity requirements are driven by annual peak flows. MWRA estimates that I/I accounts for roughly 72 to 75 percent of maximum monthly wastewater flows, a better measure of the impact on capacity.[12] Thus, the current allocation of capital costs likely subsidizes the sources of large peak flows, and reduces the incentives for communities with particularly high I/I to invest in sewer upgrades.[13]

While quantification of the environmental benefits of I/I reduction is difficult, I/I reduction will reduce the quantity and frequency of raw sewage overflows upstream of MWRA facilities resulting in reduced pollution of local wetlands, rivers, and Boston Harbor, as well as reduced incidences of raw sewage backups into homes. Staff felt that the elimination of collection system overflows during severe storm conditions would be virtually impossible but that the reduction of overflow events during marginal storms was achievable.

When we analyzed MWRA's community-by-community data on peak flows, we found that communities with the highest I/I percentage of peak month flows are likely to be the ones receiving the largest cross-subsidies from the current rate structure. Interestingly, these communities include some of the wealthier suburbs, most of which can afford to invest in sewer upgrades to reduce the problem more easily than the less affluent communities now bearing a disproportionate share of the higher costs of waste water

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[11] MWRA data from MWRA, "1997 Update on Infiltration/Inflow Reduction Strategy," Draft, August 6, 1997, p. 2. National survey data from AMSA, *The AMSA Financial Survey, 1996*, p. A-17.

[12] MWRA, Ibid.

[13] Although the recovery rate on peak flows is perhaps too low in the current rate structure, it is important to recognize that the surcharging for peaks at all is a substantial improvement, and is only possible within MWRA as a result of a substantial investment in monitoring equipment installed throughout the collection system.

treatment capital infrastructure.[14] Converting raw data on peak flows to cost accounting estimates of how much these additional flows have cost the system might enable the Authority to eliminate cross-subsidies from less-wealthy to wealthier communities.

Whether or not the political environment will allow higher charges for peak flows to some of these communities is an open question. In addition, MWRA would need to carefully evaluate how customer reactions to higher charges would affect the Authority's allocation of capital infrastructure charges. However, improved accounting for the cost of peak flows could help the authority to prioritize its own financial assistance for I/I controls. Currently, their Local Financial Assistance Program distributes money to communities to use towards reducing I/I, of which 75 percent is used for construction costs. MWRA has chosen to aggressively address this problem through zero-interest loans and grants to communities as incentives to repair and replace old wastewater mains. The funding is substantial -- $64 million over a ten-year period.[15] However, the grant program funds are allocated among all sewer communities based on respective share of overall MWRA sewerage system charges rather than based on I/I rates or CSOs. Again, there is a trade-off: each community wants its "fair share" of the grant program, yet a different allocation mechanism might well do more to reduce MWRA's aggregate costs.[16]

Allocation by Population

As noted above in Exhibit 4-3, the largest factor in allocating capital costs is population. Half of this charge is based on the sewered population within a particular town, reflecting their use of current capacity. The other half of the population charge is based on the census population, including those not currently discharging to the system. This allocation reflects the implicit standby capacity that MWRA provides as more and more of the people in these communities shift from septic systems to sewers.

The use of population for allocating overall capital does have its weaknesses, however. First of all, much of the demand for the current scale of trunklines and

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[14] See MWRA, "CY 1996 Community Wastewater Flow Estimates Ranked Flow Components," August 5, 1997. We compared peak I/I levels to average per capita income levels and found that many communities with below average incomes were paying more than their share of peak flows, while many communities with above average incomes were paying more.

[15] MWRA, "MWRA Infiltration/Inflow Reduction Strategy: Discussion with WAC, " August 8, 1997, p. 3.

[16] MWRA staff also noted that communities that had already invested substantial sums in reducing their own I/I resented subsidizing communities that had done little in this regard.

treatment capacity is due to peak flows rather than population.[17] Secondly, while collection system infrastructure is logically allocated based on census population (since it has to be installed even if few people in a town are currently using it), most of the collection systems within the towns are owned by the towns themselves, not MWRA. Other factors that would be likely to drive up collection costs, such as distance from the treatment plant (requiring more miles of trunklines and more pumping stations) are not reflected at all in rates.

The allocation of the bulk of the capital costs based on population is useful in that it minimizes the cost of wastewater treatment per capita, a possible strategy to ensure universal service. It also ensures a fairly stable rate base, since flow reduction efforts within a community do not reduce MWRA's recovery of already-spent capital. However, as noted above, the cost driver in much of the capital needed is peak flows. Peak flows, in turn, are driven by I/I, not by sanitary flows (which are linked to population). Because it reduces the incentive to curb peak flows, a population-based charge may not ration scarce capital capacity in an optimal way. In addition, the lack of surcharges based on distance from the treatment plant may hide break-points at which decentralized treatment alternatives become economic.

Centralization of Industrial Pretreatment

Cross-subsidies between communities and user groups can dilute the signals to curb wastewater discharges, driving up capital requirements and system costs; however, they do not threaten the functioning of the wastewater treatment system. Discharges from industrial users can cause plant upsets or trigger non-compliance with MWRA's NPDES permit. Thus, despite being a wholesaler, MWRA has maintained (and EPA generally requires) centralized control of its industrial pretreatment program, known as Toxic Reduction and Control (TRAC). Through centralized analysis and control not only of industrial discharges, but of non-industrial discharges of constituents of concern, TRAC has successfully reduced toxics loadings to the system. For example, levels of industrial metals released to the system were reduced by more than 50 percent between 1993 and 1996.[18] Direct oversight of industrial dischargers has eliminated the large potential problems that decentralizing oversight to the 45 sewer service communities would have caused to treatment plant operations and influent loadings of metals and toxics.

Much of this oversight has relied on regulatory approaches such as permitting, inspection, monitoring, enforcement, and penalties. Increased fees have not been used as a tool to modify discharger behavior to the extent they could be. For example, surcharges

[17] As noted above, I/I comprises 72 to 75 percent of maximum monthly flows. Since peak flows in nearly all MWRA communities occur in December, these peaks drive the demand for system capacity.

[18] Industrial metals include copper, nickel, silver, zinc, chromium, cadmium, lead and mercury. See MWRA, *Industrial Waste Report*, October 1996, pp. 5-6.

on industrial users for TSS and BOD, often an important component of the price signals that POTW's send to industrial dischargers, are levied on the city within the MWRA service area.[19] It is then up to the city to decide what proportion of the fees to pass on to industry in general, or to particular IUs. The greater the pressure within a city to be "business friendly," the more likely that other, non-industrial, users bear part of the charges for TSS and BOD.

MWRA also charges industrial dischargers a fee both for permitting and monitoring, and staff state that this fee has encouraged some IUs to reduce their discharges. Unlike strength surcharges, permit and monitoring fees are levied directly on the company, and do not go through the respective city sewer authorities. These charges use a sliding scale (based, in part, on a point system) to more accurately reflect the burden to TRAC of resource-intensive permits. This point system is rather innovative in that it reflects the relative importance of certain constituents to MWRA's NPDES and sludge disposal compliance. Those constituents which appear in concentrations nearest to MWRA's effluent and disposal limits (including copper, lead and mercury), and which could subsequently force MWRA into more expensive treatment or disposal options, receive a greater weight in determining a facility's monitoring charge.

The point system aside, industrial users are subsidized by non-industrial users. In fact, MWRA made a conscious decision not to create a pretreatment program fee structure that recovered the full costs of their program as it would have resulted in much larger industrial fees. The current fee structure (which was only implemented in 1993) aims to reduce total loadings, but is less concerned with full cost recovery.[20] As a result, permitting and monitoring charges are only meant to capture the full cost of labor time for each activity (inspecting, permit writing, permit review, and monitoring) as well as most of the laboratory costs. Users are not charged the costs of litigation and/or additional monitoring unless it is associated with a significant enforcement action. Nor is TRAC's share of MWRA administrative and overhead costs included in TRAC's fee structure.

The point system is an approximation even of the direct costs that TRAC incurs to monitor IUs. The amount charged for each permit was determined by dividing the total direct labor, materials, and services costs associated with permitting and inspecting the regulated facilities by the number of permits issued per year. Currently, this averages $2,860 per permit. Permit length (2-5 years) is dependent on the level of attention and resources determined appropriate for the category of facility. In general, more complex facilities or those discharging higher levels of pollutants of concern will pay higher permit fees ($1,430 versus $575 per year) and be issued a shorter permit. While this system does generally allocate costs back to appropriate classes of permittees, cross-subsidies within

[19] Within MWRA, these charges are levied by the Authority's Budget Department rather than TRAC. MWRA has no authority to force member communities to pass the strength surcharges back to the appropriate discharging industries.

[20] All else being equal, higher fees on loadings will generally encourage additional reductions.

IUs certainly remain. Only recently has TRAC actually tracked (on a pilot basis) employee time by activity. This would enable them to more accurately assess how their resources are being used. Whether or not the Authority decides to modify its fees based on this new cost information will depend on whether key decision makers within MWRA believe the new fees justify the potential increase in administrative burden to track costs and justify the change in fees to IUs.

TRAC is funded by MWRA's General Fund, and all permit fees and penalties collected by TRAC go to the General Fund. Annual budget appropriations to TRAC from the General Fund have no explicit linkage to fees and penalties collected from users. There is also no roll-over from year-to-year of surpluses within TRAC (surpluses revert back to MWRA's Rate Stabilization Fund), reducing the incentive to optimize budget allocations across budget years.

While fees on IUs may be artificially low (both due to TRAC fees that do not recover the full cost of oversight and to strength surcharges that towns do not pass back onto their IUs), TRAC does try to focus its outreach based on the overall impact of particular discharges on the treatment system. Two examples of this targeting are their current outreach to hospitals and dental offices to reduce mercury, and to owners of industrial cooling towers to reduce molybdenum loadings. Although there is no plan to increase fees on these dischargers to reflect the costs they force MWRA to incur, the Authority is essentially using a demand-side management approach to control the constituents of concern.

Outsourcing of Biosolids Management

MWRA has contracted with the New England Fertilizer Company (NEFCo) to barge its digested and thickened sludge from the Deer Island and Nut Island treatment plants. NEFCo then de-waters, pelletizes, and arranges for use or disposal of the biosolids. MWRA's contract with NEFCo, which is valid through 1999, stipulates that the contractor will be paid per unit of material handled, regardless of the quality of the resulting pelletized biosolids. Generally, MWRA biosolids meet EPA Table 3 ("exceptional quality") standards for land application, thereby allowing the product to be marketed, distributed, and disposed of nationally. NEFCo ships these pellets by rail to several different sites for land application or use in blended fertilizers. Occasionally, MWRA pellets do not meet the federal lead limit for unrestricted use. When this occurs, the biosolids are used only at designated land application sites or are landfilled.

NEFCo has historically spent between $16/ton and $72/ton (or an average of about $50/ton) for land application or fertilizer blending, depending on sludge quality, physical properties, and the distance to the consumer (pellets are shipped by rail as far as Colorado). According to MWRA, the current market price to landfill biosolids is $76/ton. Additionally, during 1993 MWRA signed a 30-year contract with a landfill in Utah to guarantee back up disposal capacity. This contract helped MWRA to reach an agreement with the Commonwealth of Massachusetts, EPA, and the Court to avoid constructing its own landfill, as previously required as backup for its beneficial use plans. The contract contains a guaranteed transport and tipping fee that is somewhat above current market rates. MWRA is not obliged to use this landfill if it has other disposal options. In fact, the landfill has offered lower spot rates to compete with less expensive alternatives that have been available.

This combination of factors provides an interesting example. It is cheaper to beneficially use the pelletized biosolids through land application or fertilizer blending than it is to landfill biosolids. It is therefore in NEFCo's interest to produce pellets that meet all federal guidelines for unrestricted use. However, the terms of the current contract do not vary the cost to MWRA based on biosolids contamination levels, even though reducing this contamination is much more in the control of MWRA than NEFCo. In the same way that residential pricing for wastewater services diluted the incentive for residential customers to reduce water consumption, the NEFCo contract terms have the potential to reduce MWRA's incentive to implement source reduction for contaminants in their solid residuals.

In this specific example, a number of factors do induce MWRA to act despite a lack of short-term financial penalty for contamination levels. First, there are regulatory pressures to bring down metals contamination in biosolids (in this case, Pb and Mo). In addition, the NEFCo contract is relatively short (five years). Thus, any new contract would likely penalize the Authority for contamination levels either directly through specific provisions, or indirectly through higher bid prices overall, and preparing for that contract rebid requires that MWRA start trying to reduce metals loadings now.

However, the general issue of a disparity between short-term and long-term pressures is common in many POTWs, which is why it is worth mentioning here. In the NEFCo example, MWRA staff noted that the need to obtain a new residuals management contract within only a few years was an important additional impetus to ensure that metals loadings were reduced so that all biosolids met EPA "exceptional quality" standards year-round. Many other utilities face a disparity between short- and long-term pressures from out-of-date NPDES permits or capital infrastructure that is nearing capacity but that is far more expensive to expand or replace than it was to build in the first place. It is important that POTW staff recognize how the current situation is likely to change over time so they can plan accordingly. As noted above, changes in user discharges can take years to achieve, so adjustments to rate structures, outreach, and monitoring/enforcement need to occur well in advance of the new requirements if they are to be effective.

Summary

Escondido and MWRA differ tremendously in size and scope. While local conditions dictate some of their issues of importance (such as effluent reuse in California), both face a number of similar challenges in trying to balance political and economic objectives. Both case studies illustrate how improper price signals can distort the behavior of dischargers in detrimental ways, driving up total POTW costs and potentially reducing environmental quality as well. Similarly, both illustrate the difficulties that program managers face in trying to maintain both proper price signals and a business friendly environment.

The exact issues in your POTW will likely differ from these two case examples. However, being aware of the types of cost accounting and budgeting issues that can arise and using information on the costs of existing distortions, can help you prioritize areas for immediate, medium-term, and long-term improvement.

5. SUMMARY

Improved budgeting and cost accounting can be an extremely powerful tool for POTW managers. Across nearly every aspect of the POTW, understanding how particular dischargers and discharges drive treatment costs can improve internal planning, rate setting, and the incentives to reduce pollution and peak flows. This report has provided an overview of a number of useful tools to support the transition to improved budgeting and cost accounting as well as detailed examples of what parts of your operations could likely benefit. We hope you will customize these examples to your own plants.

Implementing improved budgeting and cost accounting will not be easy. The points below will hopefully help to keep the process in perspective:

- **Focus on the Long-term**. Any single issue area, once you begin to address it, will uncover (or create) others in need of attention. The implementation process will not always be smooth. Thus, it is important not to expect immediate benefits but to look for systematic gains in understanding and control over a 2-3 year period. Implementing changes (in rates for example) after the new system has identified problem areas may also take some years. Patience is important, but the new approaches will make many changes possible that would be inconceivable without the improved ability to identify and quantify cost drivers.

- **Focus on the Utility-Level.** Systematic changes in the method used for cost accounting and budgeting cannot be done within a single division, as it is affected by, and affects, most of the other divisions in the enterprise. Changes need to be implemented across the POTW, and with the active support of top management.

- **Spend Adequate Time Focusing the Effort.** New cost accounting and budgeting systems will alter the information that managers have to make critical decisions for the organization. The information that these systems provide, and the format that they provide them in, will greatly influence the management of the utility for many years. Spend sufficient time early in the process to be sure the systems answer the questions that are most important to you, and provide data in a useful format. Be sure to get feedback on these important questions from all divisions and from all levels of the organization; the view from the utility director's office is unlikely to convey all that is important.

- **Treat the Systems as an Input to the Answer, Not the Answer Itself.** There is a temptation to take quantified data as the key input in a decision. Analytical tools help managers to structure a problem; they still require interpretation. Economically-optimal outcomes may need to be balanced against technical or political constraints. Work with key staff to understand how to interpret the new cost accounting and budgeting information so that they can use it to make better decisions without using it unquestioningly.

- **Share Lessons Learned.** Many firms have implemented the types of budgeting and cost accounting systems described here. However, the specific challenges and hurdles faced by POTWs that try to do so will likely be quite different. Be willing to ask questions of utilities who have moved in this arena sooner than you; you can learn much from them. A centralized forum (perhaps a special area of EPA's Office of Water Web site or its PIPES bulletin board for water-related issues) in which to share questions and advice on implementing improved budgeting and cost accounting might be extremely useful.

- **Be Flexible in How to Use the New Information**. If political realities prevent you from increasing fees on the large IUs driving your elevated biosolids costs, the new information on costs can nonetheless be very useful in prioritizing the use of internal resources. The net result will still be less pollution at lower cost.

GLOSSARY AND ACRONYM DIRECTORY

activity cost pools - Accounting groupings that sum all expenditures related to a particular organizational activity, used in an activity-based costing approach.

activity-based costing (ABC) - Cost accounting approach that allocates all costs within an organization to processes, products, or projects on the basis of the activities that generate those costs. Spending is grouped by activity, rather than department as is often done.

AMSA - Association of Metropolitan Sewerage Agencies, the trade association of large, municipal sewerage agencies.

average and peak demand method - Method of allocating capital infrastructure costs to system users by assigning the baseline costs based on average demand for services and allocating residual costs, assumed to be associated with peak demand, based on peak demand patterns.

benchmarking - A detailed comparison of ones own products or processes to those of other competitors or service providers to identify avenues for improvement.

capital budgeting - Process by which the POTW assesses long-term capital needs, and estimates the costs and benefits of particular capital acquisitions. An important aspect of capital budgeting is the assessment of the full annualized costs of capital services from particular plant or equipment investments.

coincident demand method - Approach used to allocate capital costs to users based on their demand for system capacity during the system's peak period.

cost accounting - Process by which costs are allocated to specific products or services so that managers can better assess how their costs vary based on different activities.

cross-subsidies - Pricing or fee systems that charge one class of users or certain activities less than the real cost of providing service. Generally, cross-subsidies are financed through higher charges on other consumers. Cross-subsidies are independent of whether a utility meets its overall revenue requirement, and tend to exist in regulated markets more often than in competitive ones.

debottlenecking - Bottlenecks in a plant are the "weak links" in production (or waste water treatment) where capacity is constrained, preventing an increased production or treatment capacity. Debottlenecking is the process of identifying and rectifying these constraints.

direct discharger - Industry with an EPA NPDES permit allowing it to discharge waste water directly to a river or stream rather than having to send it to a sewage treatment plant.

FOG - Fats, Oil, and Grease discharges into the sewer system. Term is applied to both cooking oil and petroleum-based products.

HARRF - Hale Avenue Resource Recovery Facility, the wastewater treatment plant in Escondido, CA.

historical costs - Measurement of the actual cost to install infrastructure. Historical costs, as opposed to replacement costs, are often used as a basis for pricing wastewater services and setting revenue requirements.

I/I - Inflow and Infiltration. Infiltration includes ground or surface waters entering the collection system through physical defects in collection system such as cracked pipes, deteriorated joints, or poor construction. Inflow includes flow entering the collection system from sump pumps, cross-connections, leaking tide gates, manhole covers or other non-wastewater source.

IJAs - Interjurisdictional agreements, the legally-binding contracts municipalities sign with each other governing shared services, such as wastewater treatment.

indirect discharger - Firms discharging waste water to a sewage treatment plant rather than directly to a river or stream. Indirect dischargers are regulated by the receiving POTW.

IU - Industrial Users. Refers to industries discharging to the municipal sewerage system.

lateral lines - Smaller, peripheral sewer lines in waste water collection system.

LMSD - Louisville and Jefferson County Metropolitan Sewer District.

life-cycle costing - Process of evaluating not only the direct costs of providing a product or service, but costs throughout the life-cycle. This would include such factors as the environmental impacts of producing the product and the cost of disposal.

minimum size rule - Used to allocate infrastructure shared by many users, the minimum cost rule assumes that the minimum capacity (plus a safety margin) needed to serve a standard user is a joint cost, and the incremental costs beyond that level should be borne by the subset of users requiring the larger capacity.

MWRA - Massachusetts Water Resource Authority, the oversight body for water and wastewater services for 45 communities in the Boston area.

noncoincident demand method - Approach used to allocate the costs of capital infrastructure among users based on the peak demand for the system for each individual large system user. Often used when infrastructure sizing is driven by customer rather than system peaks, such as in the size of lateral collection lines.

NPDES - National Pollutant Discharge Elimination System, used by the Environmental Protection Agency to track discharges to the nation's water bodies.

peak leveling - The need for wastewater collection, storage, and treatment capacity is driven by peak demand. Peak leveling uses a variety of market and outreach approaches to reduce the peak surges, thereby deferring the need for additional capacity.

POTW - Publicly Owned Treatment Work, wastewater treatment plants owned by the public sector.

process mapping - Systems tracking of physical processes, key task flows, and information flows within an organization. Process mapping is used to improve estimates of the real cost of a particular organizational function and to identify ways to streamline organizational processes.

replacement costs - Cost to replace existing capital infrastructure at today's prices. Replacement costs can be lower than historical costs (e.g., if technical improvements have reduced the costs of new equipment) or higher than historical costs (e.g., if labor costs, interest rates, or siting costs have risen).

resource or shadow pricing - Linear algebraic analytic approach that estimates the cost to a production objective (generally profit) from a scarcity of a particular input or resource.

TRAC - Toxic Reduction and Control Department, the division administering MWRA's industrial pretreatment program.

trunk lines - Large, central sewer lines in a waste water collection system.

unbundling - Process of disaggregating the various services provided by a utility such as wastewater collection, billing, stormwater control, to be sure that the price of each service accurately reflects the cost of providing it. Unbundling tends to remove many cross-subsidies that exist within the current pricing structure.

WWTP - Wastewater Treatment Plant.

Appendix
Memo From Water Quality Association Regarding Automatic Water Softeners

To: **WQA Manufacturers**
California Retailer Members
Interested Parties
From: **Carlyn Meyer**
Director Public Affairs
Date: **May 27, 1997**
Re: **Recent Court Decisions**

This fact sheet is intended to answer the questions most commonly asked of WQA about recent court decisions in California.

Status of California Lawsuits:

As most of you know, the 4th appellate district court in San Diego recently decided in favor of WQA regarding local water softener bans. The appeal court agreed with a lower court ruling that overturned the Escondido softener ban imposed in 1991.

We now have two published and certified court decisions, one from the 2nd appellate district court, the other from the 4th appellate district court. The California Supreme Court refused to hear the case, thereby letting the appellate decisions stand. These decisions are, therefore, precedents that all California lower courts are obliged to follow.

The appeal court's decision ends six years of WQA litigation over softener bans.

Scope of Court Rulings:

When WQA first filed in Escondido, we had anticipated that all bans before 1978 were "grand-fathered" into the California Health and Safety Code. The courts ruled that they are not. Therefore, these old bans are subject to the same interpretation of the law as Escondido and Santa Maria. This means all California residential softener bans are unenforceable.

According to WQA attorney Ladd Bedford of McQuaid, Metzler, McCormick and Van Zandt:

> "With respect to those local ordinances still on the books in California, these two published appellate decisions create binding legal precedent. As a consequence, any trial court considering these local ordinances would be bound to follow these appellate decisions and conclude that local ordinances banning or unduly restricting residential automatic water softeners which comply with state standards, are void and unenforceable."

Can Automatic Water Softeners Now Be Sold in Previously Restricted Areas throughout California?

The courts have said yes, as long as they meet a 2850 grains of hardness removed/pound of salt used efficiency rating and provided other requirements of the State Health and Safety Code Section 11678.5 are met. Be sure you also observe the laws of your local jurisdiction, including pulling permits.

A significant number of California cities experience above-average levels of salts in their source and wastewaters. Especially when they are pressured by the Regional Water Quality Control Boards to achieve waste discharge standards, this is a difficult problem for them. Accordingly, to help address this problem, WQA recommends selling only high efficiency DIR equipment in California.

We should work with local officials and other industries to help mitigate these problems. We can help by selling only high efficiency equipment and educating consumers to properly maintain their water softeners so that units remain efficient throughout their useful lives.

How will local officials respond to sales of softeners in areas that were once restricted?

This depends on the situation, but few will welcome the court decision with open arms. Some officials will accept the ruling as state law. A couple of cities are already moving to reverse bans. However, even if a city does not officially lift a ban, the court decisions say those bans cannot be enforced.

Some agencies will understand that salinity problems are larger than water softeners and require much more comprehensive water and wastewater management programs to resolve. Others will be skeptical and challenge companies selling in their area. Still others will want legal proof or to consult with their respective city attorney. A lot depends on how much local officials have followed the court case or how big the salinity problem is in their source water.

It is extremely important that you educate your local officials. Explain the softening process, especially advances in technology since the bans were first imposed in the 1960s and 1970s. It can go a long way towards building an understanding with agencies with which you have contact day in and day out.

Remember that the reaction of a local inspector or lower level staff person does not necessarily reflect the official position of a city. Be advised that - in dealing with this issue – you should talk directly with the Director of Public Works, the City Attorney or other responsible local official. They should know about the lawsuit decisions. If not, provide them with a copy of the Health and Safety Code and the appellate court decision itself.

Expect strict enforcement of rules regarding permits, installation specifications, advertising, the "3-day" cooling off period, etc. And be prepared to respond to any negative consumer information campaign on the part of a city or water district. There is nothing in the law that prohibits a local agency from "educating" consumers about softener brine and the local agency's position on softeners. (They cannot, of course, lie and mislead or say softeners are illegal.)

How will state agencies react to the court decisions?

Several state agency associations have already sponsored a "spot bill" (or "shell bill") in the California Senate (SB 360). These include the Association of California Water Agencies, the Association of California Sanitation Agencies, the League of Cities, and the Water Reuse Association. The bill's language is harmless at this time; however, it was introduced as a way to reserve space on the legislative calendar for a future amendment to include language that could be detrimental to the industry. Although we have assurances from the bill's author that he would not add such language, we can't rest on that promise alone.

WQA is poised to respond to any legislation that may be introduced by opponents to our lawsuit wins. We have kept key legislators abreast of developments in the lawsuit and have alerted them to our interests in the issue. WQA's position also has support from many sizable end-user groups, such as those representing hotels, restaurants, laundries and hospitals.

We have made it clear that the industry could support legislation containing tougher standards than what presently exists in state law but which meet current industry capabilities (DIR, 3350 grains removed), provided local jurisdictions are not given the authority to ban products.

The water and sanitation agencies will continue to portray their position as serving the public good. However, many legislators have tax-paying constituencies who would suffer if they were prohibited from using softeners.

Other issues that may be raised

Q: Can a private homeowners association ban water softeners as part of its covenant?

A: They may be able to, depending upon how the covenant is written. Condominium association agreements are more or less contracts entered into voluntarily by private citizens.

Q: What if my local officials say they are banning brine discharge under the sewer laws, not water softeners per se?

A: Several districts have brought this up. It may be a way to circumvent the court decisions. However, a district cannot single out water softeners. It would be in violation of state law.

Q: My city says that the Regional Water Quality Control Board bans water softeners.

A: This is nonsense. The Regional Water Quality Control Board sets standards for municipal sewage treatment plants. Some cities believe that if they are in violation of those discharge standards setting TDS limits, it gives them the right to ban water softeners. It does not. Plus, the Regional Water Quality Control Board does not have the power itself to ban water softeners or even to tell cities what specific actions to take to comply with board-issued standards. Neither do the State Water Resources Control Board or the EPA.

To receive a copy of the appellate court decision or the California Health and Safety Code, fax your request to WQA at 630-505-9637.

CAM/al

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